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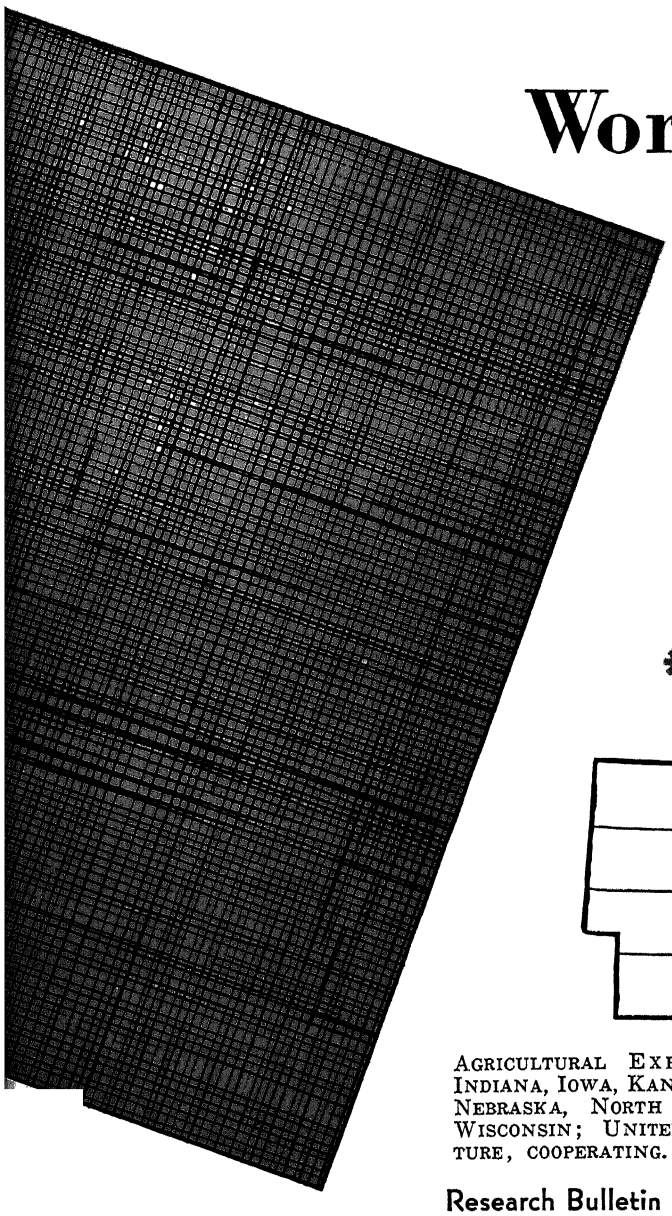

Work Counter SURFACE FINISHES

for kitchens and utility areas

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AGRICULTURAL EXPERIMENT STATIONS OF ILLINOIS, INDIANA, IOWA, KANSAS, MICHIGAN, MINNESOTA, MISSOURI, NEBRASKA, NORTH DAKOTA, OHIO, SOUTH DAKOTA, WISCONSIN; UNITED STATES DEPARTMENT OF AGRICULTURE, COOPERATING.

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WORK COUNTER SURFACE FINISHES FOR KITCHENS AND UTILITY AREAS

ELAINE KNOWLES WEAVER and VELMA VIZEDOM EVERHART

INTRODUCTION

"The kitchen is the woman's kingdom" is a saying frequently made and one that may be argued pro and con but the fact is that each homemaker, as well as members of her family, spends a goodly share of the homemaking hours in this room. According to studies made, about 55 percent of an average of 52 working hours per week are spent in the kitchen.[1] Besides the task of food preparation (two and one-half hours per day) and dishwashing (one hour and fifteen minutes per day), the kitchen may also be the center for such activities as dining, food preservation, washing and ironing, sewing, child care, and recreation. Whatever the activity may be, it is more than likely that a work counter or table will be in use. In some homes where a utility or work room may supplement the kitchen for some activities other work counters will be in use. The counters in either or both areas will have some surface finish.

Remembered are the days of oil cloth and rough woods as counter finishes. With developments in modern kitchens have come new materials that are not only pleasing to the eye but also are practical, durable and easy to clean.

Porcelain enameled tops for kitchen cabinets and work tables enjoyed a decade or two of popularity following the first World War, stainless steel and ceramic tile gained some popularity in homes where they could be afforded.

In the 1930's when kitchen design was streamlined and continuous work counters became popular, inlaid linoleum was found to be a flexible and economical material and during the past twenty years has been used in a large majority of new and remodeled kitchens.

Following World War II the development of synthetic materials has progressed with such rapid strides that new laminated plastics and vinyls in various grades have been made available and extensively promoted for

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[1]Time Spent in Homemaking Tasks, Jean Muir Dorsey, Urbana, Illinois. (Compilation of time studies, unpublished.)

counter finishes. The market now offers such choices as linoleums, laminated thermoset plastics, vinyls, stainless metals, ceramic tiles, marbles, pressed woods, and natural woods with various penetrating treatments. (For description of materials, see Appendix, pages ————————

The greater the choice of materials on the market, the greater the confusion in selection on the part of the consumer. Advertising claims of the new materials have caught the eyes of families who are prospective builders, intend to remodel or merely replace badly worn surfaces. Because of the lack of specific information concerning the relative merits of materials available, the consumers have been dependent upon the advice of contractors, dealers, or experiences of other families.

Requests for information have come frequently to the Ohio Agricultural Experiment Station from the North Central Region as well as from individuals and colleges in other regions of the United States and from several foreign countries. Such requests indicated the need for an investigation which would make available some facts that would help prospective buyers to understand the characteristics of the various materials and what to expect of them.

PURPOSES FOR THIS STUDY

One of the purposes for this study was to find the answers to the questions coming from residents of Ohio and other states for information as to the various materials available for work counter finishes.

These requests included such questions as: "What is the 'best' material for work counters?" "What are laminated plastics?" "Could I install 'it' myself?" "How many different kinds are there?" "Will these *new* materials stain or 'rot' around the sink?" "Will they crack or break?" "The salesman said vinyl would outwear linoleum. Will it?" "What is a vinyl?" "How do the different materials compare as to cost?" "Which one will wear the longest?" "Which ones won't stain?"

In order to find the answers to these and other questions it was believed necessary to:

1. Find out (a) how many companies manufactured a product which they recommended for use as a work counter surface material; (b) the processes used for making the products and recommendations as to installation, use, and care.
2. Visit a given group of homemakers to find out their likes, dislikes and problems with various materials as a guide to a laboratory investigation.

3. Evaluate materials under controlled laboratory conditions for factors such as moisture absorption, abrasion, impact, heat, and chemical effects to which they might be subjected in the home.
4. Ascertain comparative costs of some of the most frequently used materials by submitting representative kitchen plans to contractors and suppliers for estimates for costs of material and installation.

The procedures used and the information gleaned in this study will be reported in the following sections.

WORK COUNTER SURFACE MATERIALS AVAILABLE ON THE MARKET

To ascertain the materials that might be available for work counter surfaces a list of manufacturers of laminated thermoset plastic, vinyl, linoleum, tile, stainless steel, marble, and pressed wood was found by consulting the classified section of the Thomas Register.[2] Approximately 250 form letters were sent to manufacturers listed in this register asking if their product was made specifically for home use as a work counter surface material in kitchens or utility rooms.

Four-fifths or 188 of the replies from these manufactures indicated industrial rather than home use of their product. Several of the companies, however, referred us to a fabricator of their product who finished it for use in homes. Of the companies and the fabricators to whom we were referred only 50 companies reported that they made materials specified for home use.

In order to get a representative list of locally used materials 28 distributors and retailers in the Columbus, Ohio, area were surveyed. They indicated that their sales were mainly of two brand names of linoleum, three of vinyls, eight of laminated plastics, three of stainless steels, two of tiles, and one of pressed wood. The manufacturers of these materials cooperated by providing a sufficient amount of these products for laboratory study and for illustrative and educational materials.

PROBLEMS AND OPINIONS OF HOMEMAKERS

To learn of actual problems women encountered in the use of various materials on work counters, 102 homemakers in Franklin County, Ohio, were interviewed. (See questionnaire, Appendix, page ??.) Of this number, approximately two-thirds were in urban and one-third were in village or rural homes. No attempt was made to get a representative

[2]Thomas Register, 1950 Edition, Thomas Publishing Co., 473 8th Ave., New York 1, N. Y.

sampling. Lists of names of people in whose homes installations had been made within the past 10 years were obtained from dealers of various counter surface materials. These lists provided a sample of homes in which a variety of materials were represented.

Approximately one-third of those women interviewed lived in houses built within the past 10 years, while over one-third lived in houses over 25 years old. Ninety-four of the 102 families owned or were paying for their homes.

WHAT MATERIALS WERE USED ON THE WORK COUNTERS?

In 73 of the kitchens only one surface material was in use. The variety of materials included:

Material	No. of homes
Linoleum	30
Laminated plastics	20
Vinyl	7
Stainless steel	5
Wood (treated)	4
Porcelain enamel	3
Tile	2
Marble	2
	73

In the remaining 29 homes there was a combination of two or more materials.

DID THESE HOMEMAKERS CONSIDER THE WORK SURFACE MATERIAL USED SATISFACTORY?

Material	Yes	No
Linoleum	31	10
Vinyl	7	0
Laminated plastics	29	0
Stainless steel	18	0
Marble	5	0
Porcelain enamel	5	1
Wood	6	2
Tile	4	0

Stains and deterioration around sinks were the main grievances against linoleum. Observations indicated poor installation or lack of care was responsible generally for these problems.

Vinyl installations were all comparatively new and well liked. Occasional spots were observed but were considered temporary. Users seemed satisfied with the product.

As with vinyl, laminated plastic materials are a recent development and these installations were all fairly new. While scratches and surface cuts were visible in a number of cases the owners were satisfied. In one home a glass falling from a cupboard had dented and cracked the laminated plastic surface.

In spite of observed abrasion spots, scratches, and water marks, all owners liked stainless steel and considered it completely satisfactory. No specific comments were given concerning other materials.

WHAT PROBLEMS WERE ENCOUNTERED IN THE USE OF THE DIFFERENT WORK COUNTER MATERIALS?

The greatest problems to homemakers seemed to be those of water stain, rot, mildew, scratches, and abrasion. The number and kinds of complaints of staining were less than anticipated by interviewers.

Stains. Stains believed by women to be permanent, included those caused by water, vinegar, lemon juice, chlorine bleach, soap, synthetic detergents, tea, coffee, heat, milk, grape juice, ammonia, mayonnaise, fat, food coloring, acid, and rust. Rust stains, most frequently mentioned, were caused by wet skillets, canister sets, scouring powder and other cans, and steel wool left standing on damp surface areas.

The majority of complaints of stains were from homes where linoleum had been in use for 10 years or more.

Pitting, rotting, and mildewing. Pitting of the surface material was a complaint in 10 homes. Causes were attributed to food grinder, water, soap, and cutting. Fourteen complaints had to do with rotted material around sinks or water pipes believed to be due to water, soap, or synthetic detergents.

Scratches and abrasion. Seventy-seven women reported scratches or cuts from knives, rough corners of utensils, and toys. Abrasion reported by 43 women resulted from dishes, utensils, metal trays, and unknown causes. Ninety-two of the women had cutting boards of some type of which 73 said they always used them for cutting or chopping. The remainder of the homemakers said that they often cut directly on the counter surface. About half of the women would prefer to have a permanent cutting board installed as a part of the work counter to a separate cutting board elsewhere from the work area.

Burns. In 11 homes burned spots on surfaces were due to cigarettes, coffee makers, popcorn poppers, flat irons, waffle makers, and hot lead.

Other problems. Dents observed in surfaces in two homes were due to falling objects. In several homes the surface had warped or buckled or had loosened at corners. In other homes occasional complaints included cracking or fading of color.

WHAT DETERMINED THE CHOICE OF WORK COUNTER SURFACE MATERIAL?

All of the homemakers were asked what factors they had considered most important in choosing their present surface materials or, in case they had not had the opportunity to select it, what they would consider desirable when replacing it. The most commonly mentioned factors were:

Durability	45 percent of women
Material easily cared for	27 percent of women
Cost	23 percent of women
Appearance	23 percent of women
Color	13 percent of women

Other factors mentioned more than once were:

Influence of friends or salesmen
Resistance to stains
Resistance to heat and cold
Resiliency
Material to match floors
Fads
Surface material supplied with cabinets
Availability through family or friends at a discount

WOULD THEY LIKE MORE THAN ONE MATERIAL ON WORK COUNTER SURFACES?

If replacing their work counter finish, about two-thirds of the women thought they would like more than one material. Of this group, 23.8 percent would choose laminated plastics and hard wood; 22.4 percent, stainless steel and laminated plastics; 13.4 percent, stainless steel and hard wood; 10.4 percent, stainless steel and linoleum; 7.5 percent, linoleum and hard wood.

SUMMARY

Factors found in the 102 homes visited, such as length of occupancy, and types, variety, condition and age of surface finish, were too variable to make definite conclusions regarding satisfaction with the finishes.

Problems and complaints, such as staining, scratching, abrasion, water absorption, cracking, scorching, and burning, provided directives toward the laboratory testing program which followed.

LABORATORY STUDIES OF A SELECTED GROUP OF WORK COUNTER SURFACE MATERIALS

It was recognized that laboratory tests could not duplicate home conditions in the use of work counter surface finishes. Nevertheless, subjecting the various materials under controlled conditions to certain treatments which might exist in homes was considered of value.

In homes these surface finishes might be subjected to certain treatments accidentally, carelessly or through lack of knowledge, which could affect appearance or wearing quality. The effects might be classified as:

(1) **Chemical**—*staining or deterioration* by acids, alkalis, or solvents such as foodstuffs, vinegar, soaps and synthetic detergents, cleaning fluids, acetone, oils, medical supplies and the like. Then, too, damp or humid conditions were known to create mildew and mold and/or deterioration of certain materials. (2) **Physical**—*abrasion or scratching* by pulling skillets, pans or dishes across surface; *cutting* with sharp knives or other tools; *impact* by dropping an object; *heat* by placing a hot object or spilling hot food or liquid; *fading* by natural or artificial light.

Investigation revealed that the manufacturers of different classifications of materials had various means of testing their products and comparing them with other brands of the same classification. No one series of tests applicable to all materials could be found.

For purposes of this study the standards provided by the National Electrical Manufacturers Association for testing performance, fabrication and application of laminated thermosetting decorative sheets[3] were used as a basis for establishing our tests and the techniques employed.

Surface materials subjected to testing. Twenty work surface materials, nationally advertised and available on the local markets, were selected from the 50 materials that various manufacturers had indicated were suitable for home use. Time, funds, and laboratory facilities could not provide for study of all materials indicated by the manufacturers as suitable for such finishes.

Because of the policy of the Ohio Agricultural Experiment Station to avoid use of trade names in publications, the materials tested will be known by a code number. In the report of the following tests the 8 laminated plastics will be listed as LP 1 to 8; vinyls, V 1 to 3; linoleum, L_1 a and b and L_2 a, b and c (more than one grade of each brand was used); steel, S 1 to 3; tile, T 1 and 2; and pressed wood, W 1. (For description of the various materials, see Table —, pages — to —.

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[3]Standards and Recommended Practices for Fabricating and Applying Laminated Thermosetting Decorative Sheets, Pub. No. LP2—June 1951, National Electrical Manufacturers Association, 155 E. 44th Street, New York 17, New York.

LABORATORY TESTS EMPLOYED FOR COUNTER FINISHES

INTRODUCTION

Two tests which might be classified as *chemical effects* were employed and included resistance to stain and moisture absorption. Six tests relative to *physical effects* included resistance to wear (abrasion), cuts, dry and moist heat, burns, impact and sunlight.

The tests for resistance to stain, heat, cuts, burns, and fading were done by a home economist at the School of Home Economics, The Ohio State University. Moisture absorption tests were done by a ceramic engineering student in the engineering laboratory at The Ohio State University under the direction of a staff member of the department. Wear and impact tests were done by an engineering technician at the School of Home Economics.

Since the results of the tests required subjective appraisal, a panel of six judges served throughout the study. This panel included four experienced home economists in the household equipment and home management areas, a member of the staff of Agricultural Engineering, and a chemical engineer from Battelle Memorial Institute.

The specific tests and methods used for scoring the products will be described in the following pages.

Test I. Resistance to Staining

In the course of the day or week work counter surfaces are in use during activities of food preparation, dishwashing, laundering, and a multiplicity of other tasks. They are subjected to a great variety of foodstuffs, acids, alkalis, and other materials which have been known to cause temporary or permanent stains. Some materials cause stains which may be merely unsightly while others not only stain but also may cause some degree of deterioration.

Methods employed for testing:

A. Test specimen:

Two test specimens, 2 by 4 inches, were cut from each of the 20 surface finish materials for each of 38 stain tests. The surface finish of each test specimen was wet-rubbed with FFF pumice to remove the surface gloss only, washed with a mild soap and rinsed with clear water.

B. Test procedure:

Two tests, in parallel, were made by applying the stain material to both test specimens; one was covered with a 1½-inch

diameter watch glass and the second was left uncovered. The samples were left for 16 hours in a control room at a temperature of 70° F. and a relative humidity of 60 percent. At the end of 16 hours, the samples were washed with water and then with a solvent, ethyl alcohol.

C. Materials used for stain tests:

For stain tests materials considered most likely to cause a chemical reaction with the work surface material or those containing coloring matter which might be retained by the surface material were used.

D. Scoring the test specimens:

Following the cleaning of the test specimens they were scored by a panel of 6 judges according to the degree or amount of stain or any change in surface texture. (See Tables 1, 2, and 3.)

Results of the Tests:

All of the surface finish materials used in the stain tests were new. It is probable that these new materials were more resistant to staining than they would have been had they been subjected to abrasion, moisture, and other home conditions over a period of time.

Certain foodstuffs such as lemon juice and vinegar are mildly acid. When these substances were left on the surface finishes for 16 hours, all linoleums, vinyls, 1 tile, 2 steels, and the wood showed a minor degree of staining which could not be removed. No degree of stain from these acids could be observed on 8 of the 9 laminated plastics, 1 steel, and 1 tile. Food colorings stained 10 and mustard, 14 of the 24 test materials. (See Table 1.)

The all-purpose detergent left stains on 17 and all-purpose soap, on 11 of the 20 test pieces. All linoleum and vinyl and 2 of the steel specimens were stained by the liquid synthetic detergent used for dishwashing. Hand soap showed minor or no effects on any one of the materials. The same was true of the *mild* synthetic powdered detergent. Liquid bleach noticeably or badly stained all linoleum but affected only one each of the vinyl and laminated plastics, and 2 steel specimens. Ammonia affected more materials than did bleach. Drain cleanser, either wet or dry, and liquid disinfectant affected all materials except laminated plastics and glazed tile (Table 2).

TABLE 1.—The Resistance of Work Counter Surface Materials to Staining by Foods as Scored by a Panel of Six Judges*

Work counter surface material	Foodstuffs								
	Lemon juice	Vinegar	Mustard	Grape juice	Frozen coffee	Tea	Food coloring	Olive oil	Melted lard
	Average score for degree of stain								
Linoleum									
L 1a	3.66	3.33	3.00	4.00	4.00	4.00	2.66	3.83	4.00
L 1b	3.66	3.00	3.00	3.33	4.00	3.33	1.83	3.83	4.00
L 2a	3.66	3.50	3.00	4.00	3.40	3.66	2.83	4.00	4.00
L 2b	3.66	3.50	3.50	4.00	4.00	3.50	3.17	4.00	4.00
L 2c	3.66	3.33	3.33	3.17	4.00	3.33	2.33	4.00	4.00
Vinyl									
V 1	3.83	3.00	3.66	3.17	3.66	3.33	3.83	4.00	4.00
V 2	3.66	3.83	3.83	4.00	4.00	4.00	3.83	4.00	4.00
V 3	3.83	3.33	3.66	4.00	4.00	4.00	2.00	4.00	4.00
Laminated Plastic									
LP 1	4.00	4.00	4.00	3.83	3.83	4.00	3.83	4.00	3.83
LP 2	4.00	4.00	3.83	3.83	3.83	4.00	4.00	4.00	4.00
LP 3	4.00	4.00	4.00	4.00	3.83	4.00	3.83	4.00	4.00
LP 4	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
LP 5	3.83	4.00	4.00	4.00	4.00	4.00	4.00	3.83	4.00
LP 6a	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
LP 6b	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
LP 7	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
LP 8	4.00	4.00	3.83	3.83	3.83	3.83	3.66	4.00	4.00
Steel									
S 1	2.66	2.83	3.17	3.33	3.33	3.83	3.50	4.00	4.00
S 2	3.50	3.66	3.17	2.33	3.00	3.33	3.50	4.00	4.00
S 3	4.00	4.00	4.00	4.00	4 00	4.00	4.00	4.00	4.00
Tile									
T 1	3.83	4.00	4.00	4.00	4.00	4.00	4.00	3.83	2.33
T 2a	4.00	4.00	4.00	4.00	4 00	4.00	4.00	4.00	4.00
T 2b	4.00	4.00	3.73	4.00	4 00	4.00	4.00	4.00	4.00
Wood									
W 1	2.17	4.00	4.00	4.00	2.17	2.66	1.33	2.66	2.83

*4 points—no stain
3 points—slight stain
2 points—moderate stain
1 point —considerable stain
0 points—badly stained

Linoleums and vinyls were particularly susceptible to mercurochrome, merthiolate and iodine which also left permanent stains on plain finished steel but did not affect laminated plastics. Likewise, nail polish and removers, while staining linoleum and vinyl, had no effect except on surface glaze of 2 of the laminated plastics. Ink and shoe polish, on the other hand, stained all materials except laminated plastics 4 and 8, steel 3, and tile 2a. All laminated plastics were resistant to one of the household tints or dye materials but 3 of them were stained by a second brand of that material.

The results of the staining on the wood specimen as noted in the tables indicates the need for a sealing treatment for wood surfaces according to manufacturers' directions.

All 3 steel specimens and the wood retained water stains and were the only materials upon which water (used as a staining material) showed any effect.

Steel, S 3, showed more resistance to staining than did the other steel specimens. S 3 was finely corrugated or patterned, whereas others were flat surfaced, and provided what might be termed an optical illusion—breaking the staining effect so that it was not evident as the specimen was inspected under lights at different angles. When the test pieces were washed and rinsed with clear water a number of the stains on some materials made by grape juice, tea, merthiolate, nail polish, and the like appeared to be permanent. When washed with alcohol some or all of the stain disappeared. For results of staining following abrasion tests, see page ————————.

While ethyl alcohol could hardly be used for the purpose of removing stains from surface finishes at home, because of cost and medical prescription required for purchase, it served as a good solvent in these tests. Chemists advise that rubbing or denatured alcohol could serve the same purpose.

Test II. Resistance to Heat

For the sake of convenience the homemaker would prefer a counter finish that could withstand hot utensils directly from the top of the range or from the oven without need for hot pads and racks for protection. Likewise with the frequent use of such electrical appliances as deep fat fryers, waffle irons, toasters, casseroles, coffeemakers, and roasters the question arises as to risk of damage if she does not place them on insulated protectors. Then, too, when washing dishes she may rinse them with boiling water which might be splattered or inadvertently poured on the work surface.

TABLE 2.—The Resistance of Work Counter Surface Materials to Cleansing Material Stains as Scored by a Panel of Six Judges*

Work counter surface material	Cleansing Materials													
	Mild detergent	All-purpose soap	All-purpose detergent	Hand soap	Liquid detergent	Liquid bleach	Bluing	Dry-cleaning solvent	Carbon tetrachloride	Household ammonia	Drain cleanser (wet)	Drain cleanser (dry)	Disinfectant	Scratch remover
	Average score for staining													
Linoleum														
L 1a	4.00	3.83	3.50	4.00	2.83	2.00	3.50	3.83	4.00	3.83	1.17	1.00	2.33	4.00
L 1b	4.00	2.17	2.00	4.00	2.50	1.83	2.00	3.66	3.80	1.33	1.00	1.00	1.50	3.83
L 2a	4.00	3.83	3.50	4.00	3.17	1.66	3.83	3.66	4.00	3.00	1.00	1.00	2.17	4.00
L 2b	3.83	3.50	2.33	4.00	3.00	1.66	3.83	3.83	4.00	3.00	1.17	1.00	2.33	3.66
L 2c	4.00	3.00	2.50	4.00	3.00	1.83	3.83	3.83	4.00	3.50	1.17	1.00	2.66	3.66
Vinyl														
V 1	4.00	4.00	4.00	3.17	3.66	4.00	1.66	4.00	4.00	3.17	3.17	3.66	3.00	3.50
V 2	4.00	4.00	3.66	4.00	3.83	4.00	3.83	4.00	3.80	3.83	3.83	3.66	3.83	3.66
V 3	4.00	1.83	1.83	4.00	2.83	2.66	3.66	4.00	4.00	3.83	2.83	2.33	3.66	3.66
Laminated Plastic														
LP 1	4.00	4.00	4.00	4.00	4.00	4.00	3.83	4.00	4.00	3.83	3.33	4.00	4.00	3.66
LP 2	3.83	4.00	4.00	4.00	4.00	4.00	3.83	4.00	4.00	3.66	3.83	4.00	4.00	4.00
LP 3	4.00	4.00	4.00	4.00	4.00	4.00	3.83	4.00	4.00	4.00	3.83	4.00	4.00	4.00
LP 4	4.00	4.00	4.00	4.00	4.00	4.00	3.83	4.00	4.00	4.00	3.00	4.00	4.00	4.00
LP 5	4.00	3.83	4.00	4.00	4.00	2.00	3.83	4.00	4.00	4.00	3.50	4.00	4.00	4.00
LP 6a	4.00	4.00	3.66	4.00	4.00	4.00	3.83	4.00	4.00	3.66	4.00	4.00	4.00	4.00
LP 6b	4.00	4.00	4.00	4.00	4.00	4.00	3.83	4.00	4.00	4.00	3.50	4.00	4.00	3.83
LP 7	3.66	4.00	3.50	4.00	4.00	4.00	3.83	4.00	4.00	4.00	4.00	4.00	4.00	3.00
LP 8	3.66	4.00	3.83	3.83	4.00	4.00	3.83	4.00	4.00	4.00	3.66	4.00	4.00	4.00

TABLE 2.—The Resistance of Work Counter Surface Materials to Cleansing Material Stains as Scored by a Panel of Six Judges*—Continued

Work counter surface material	Cleansing Materials													
	Mild detergent	All-purpose soap	All-purpose detergent	Hand soap	Liquid detergent	Liquid bleach	Bluing	Dry-cleaning solvent	Carbon tetrachloride	Household ammonia	Drain cleanser (wet)	Drain cleanser (dry)	Disinfectant	Scratch remover
Steel														
S 1	3.66	3.00	2.00	4.00	3.33	3.17	3.66	3.83	3.00	3.00	2.66	3.66	3.50	4.00
S 2	3.50	3.33	1.66	4.00	3.33	3.50	3.83	3.66	2.60	3.00	2.20	2.75	3.33	4.00
S 3	3.83	4.00	2.00	3.66	4.00	4.00	4.00	4.00	4.00	4.00	1.66	3.50	4.00	4.00
Tile														
T 1	4.00	3.80	2.17	4.00	2.83	2.00	4.00	4.00	4.00	3.83	3.33	1.00	2.50	1.66
T 2a	4.00	4.00	2.66	4.00	4.00	4.00	4.00	4.00	4.00	3.83	4.00	4.00	4.00	3.83
T 2b	4.00	4.00	3.25	4.00	4.00	3.50	2.75	4.00	4.00	4.00	4.00	4.00	4.00	1.75
Wood														
W 1	3.33	3.66	2.00	3.50	1.50	1.00	1.17	4.00	4.00	4.00	1.00	1.33	3.83	1.33

*4 points—no stain
3 points—slight stain
2 points—moderate stain
1 point —considerable stain
0 points—badly stained

TABLE 3.—The Resistance of Work Counter Surface Materials to Staining by Medical and Miscellaneous Supplies as Scored by a Panel of Six Judges*

Work counter surface material	Medical Supplies				Miscellaneous Supplies										
	Mercuro-chrome	Merthi-olate	Iodine	Ethyl alcohol	Nail polish	Ace-tone	Amyl Ace-tate	Ink	DDT	Fly spray	Shoe polish	Crayon	Household tint or dye (1)	Household tint or dye (2)	Water
	Average score for stain														
Linoleum															
L 1a	3.50	2.66	1.00	3.40	3.17	3.50	3.83	3.00	3.83	4.00	1.00	3.83	2.66	2.33	4.00
L 1b	2.83	1.66	1.00	3.20	3.17	3.33	3.83	1.50	3.83	4.00	1.00	3.17	2.00	2.33	4.00
L 2a	3.00	3.17	1.00	4.00	3.17	3.33	3.83	2.33	4.00	4.00	1.00	3.50	2.83	2.50	4.00
L 2b	3.00	2.66	1.00	3.60	3.00	3.50	3.66	3.66	4.00	4.00	1.00	3.66	3.83	3.00	4.00
L 2c	2.00	1.66	1.00	4.00	2.83	3.17	3 83	3.17	4.00	4.00	1.00	3.50	3.50	2.50	4.00
Vinyl															
V 1	1.17	3.66	1.83	4.00	2.83	2.83	4.00	2.50	4.00	4.00	1.00	1.33	1.17	1.17	4.00
V 2	3.50	4.00	2.17	4.00	3.50	3.50	4.00	3.66	4.00	4.00	1.00	3.50	3.17	1.83	4.00
V 3	1.66	1.66	2.50	4.00	2.33	3.50	4.00	2.50	4.00	4.00	1.00	2.66	3.50	2.33	4.00
Laminated Plastic															
LP 1	3.17	4.00	3.83	4.00	3.66	4.00	4.00	3.83	4.00	4.00	3.50	4.00	4.00	3.33	4.00
LP 2	3.00	4.00	2.50	4.00	3.66	4 00	4.00	3.83	4 00	4.00	3.66	3.83	4.00	3.50	4.00
LP 3	3.50	4.00	3.22	4.00	4.00	4.00	4.00	3.83	4.00	4.00	4.00	4.00	4.00	2.50	4.00
LP 4	3.83	4.00	3.22	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.83	4.00	4.00	4.00	4.00
LP 5	4.00	4.00	3.00	4.00	4.00	4.00	4.00	3.83	4.00	4.00	4 00	4.00	4.00	4.00	4.00
LP 6a	4.00	4.00	3.50	4.00	4.00	4.00	4.00	3.83	4.00	4.00	4 00	4.00	4 00	4.00	4 00
LP 6b	3.83	4.00	3.40	4.00	4.00	4.00	4.00	3.83	4.00	4.00	4.00	4.00	4.00	4.00	4.00
LP 7	3.66	4.00	3.50	4.00	4.00	4.00	4 00	3.83	4.00	4.00	4.00	4.00	4.00	4.00	4.00
LP 8	3.17	4.00	3.83	4.00	4.00	4.00	3.17	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00

TABLE 3.—The Resistance of Work Counter Surface Materials to Staining by Medical and Miscellaneous Supplies as Scored by a Panel of Six Judges*—Continued

Work counter surface material	Medical Supplies				Miscellaneous Supplies										
	Mercuro-chrome	Merthi-olate	Iodine	Ethyl alcohol	Nail polish	Ace-tone	Amyl Ace-tate	Ink	DDT	Fly spray	Shoe polish	Crayon	Household tint or dye (1)	Household tint or dye (2)	Water
Steel															
S 1	4.00	2.83	2.66	3.80	3.33	3.66	3.66	2.66	3.83	4.00	4.00	3.83	3.00	3.50	3.33
S 2	3.83	2.66	3.25	3.60	4.00	3.17	3.00	3.17	3.83	3.83	4.00	3.60	3.20	3.83	3.50
S 3	4.00	4.00	4.00	4.00	3.50	4.00	4.00	4.00	4.00	4.00	4.00	3.83	4.00	4.00	3.50
Tile															
T 1	4.00	4.00	2.83	4.00	3.50	4.00	4.00	2.00	4.00	4.00	3.83	4.00	3.83	4.00	4.00
T 2a	4.00	4.00	3.83	4.00	3.66	4.00	4.00	4.00	4.00	4.00	4.00	3.83	4.00	4.00	4.00
T 2b	4.00	3.50	4.00	4.00	2.75	4.00	4.00	2.00	4.00	4.00	3.00	3.50	3.25	3.50	4.00
Wood															
W 1	1.00	1.66	2.66	3.40	2.83	4.00	4.00	1.66	4.00	3.50	3.33	1.17	1.33	1.00	3.50

*4 points—no stain
3 points—slight stain
2 points—moderate stain
1 point —considerable stain
0 points—badly stained

Test Procedures:

To appraise the materials by laboratory tests two separate procedures were used:

1. Dry heat

   A one-pint saucepan with a flat bottom was almost completely filled with Fisher Bath Wax and heated to temperatures of 350° F., 382° F., and 420° F., respectively. When a designated temperature was reached the pan was placed at the center of a 9-inch square of the test specimen, which had been clamped to the heat insulating wood, and allowed to remain for 20 minutes.

   All materials were tested at 420° F. and at 382° F. If they showed very little or no stain at the latter temperature they were not tested at 350° F.

2. Wet heat

   One 9-inch square of each of the materials was clamped to the heat insulated board as described above. A one-pint, flat bottom saucepan (identical to test above) was almost completely filled with tap water (5 grain hardness) and heated until it boiled vigorously (approximately 211.5° F. at Columbus, Ohio, altitude). A small amount of the boiling water was spilled on the surface of the test sample and the pan containing the remainder of the water was set in the puddle and allowed to stand for 20 minutes.

Upon completion of the testing procedures a panel of six judges rated the samples for resistance to scorch or color change on both top surface and backing, warping and/or blistering, or other discernible surface disturbances. (See Table 4.)

Results of the test:

When linoleum samples were subjected to dry heat at 420° F. such as that of a preheated skillet directly from the heat source, all were scorched. (Figure 1). With thinner gauge materials the scorch pattern penetrated the backing. Much the same response was true at 382° F. although the scorch pattern was a bit lighter. At 350° F. the change appeared to be merely surface damage. Boiling water caused slight color changes which were still noticeable under good light several weeks later.

Vinyl materials were more susceptible to heat than were the linoleums. At 420° F. and 382° F. the pan stuck to all 3 vinyl specimens and blistering, discoloration, and roughening occurred. At 350° F.

TABLE 4.—The Resistance of Work Counter Finishes to High Temperatures as Scored by a Panel of Six Judges*

Work surface material	212° F. (wet)	350° F. (dry)	382° F. (dry)	420° F. (dry)	How material responded at 420° F.
	Average score	Average score	Average score	Average score	
Linoleum					
L 1a	3.33	2.66	1.17	1.00	Heavily scorched
L 1b	3.66	3.50	1.17	1.00	Heavily scorched
L 2a	3.33	3.66	1.17	1.00	Heavily scorched
L 2b	3.00	3.66	2.17	1.50	Moderately scorched
L 2c			1.66		
Vinyls					
V 1	3.66	1.50	1.17	1.00	Pan stuck, blistered
V 2	2.83	1.66	1.33	1.00	Pan stuck, blistered, discolored
V 3	3.00	1.66	2.00	1.25	Slight sticking, roughened
Laminated Plastic					
LP 1	4.00	†	3.00	2.50	Small bubble
LP 2	3.83		4.00	3.75	Slight color change
LP 3	3.83		3.20	2.50	Small bubble
LP 4	3.66		3.50	1.25	Large bubble
LP 5	3.66		4.00	3.75	Slight color change
LP 6a	4.00		4.00	3.25	Darkened in color
LP 6b				3.25	Darkened in color
LP 7	3.83		3.50	2.75	Little change
LP 8	3.17		3.33	2.75	Edges curled back
Steel					
S 1	2.33		3.83	3.50	Very slight discoloration
S 2	2.33		3.83	3.75	Very slight discoloration
S 3	3.00		3.83	3.75	Very slight discoloration
Tile					
T 1	4.00		4.00	4.00	No change
T 2a	4.00		4.00	4.00	No change
T 2b	4.00		4.00	4.00	No change
Wood					
W 1	2.50		3.25	2.75	Scorch

*4 points—no change
3 points—slight change
2 points—moderate change
1 point —considerable change
0 points—very badly damaged

†When very slight or no change was observed on tests at 382° F., the materials were not tested at 350° F.

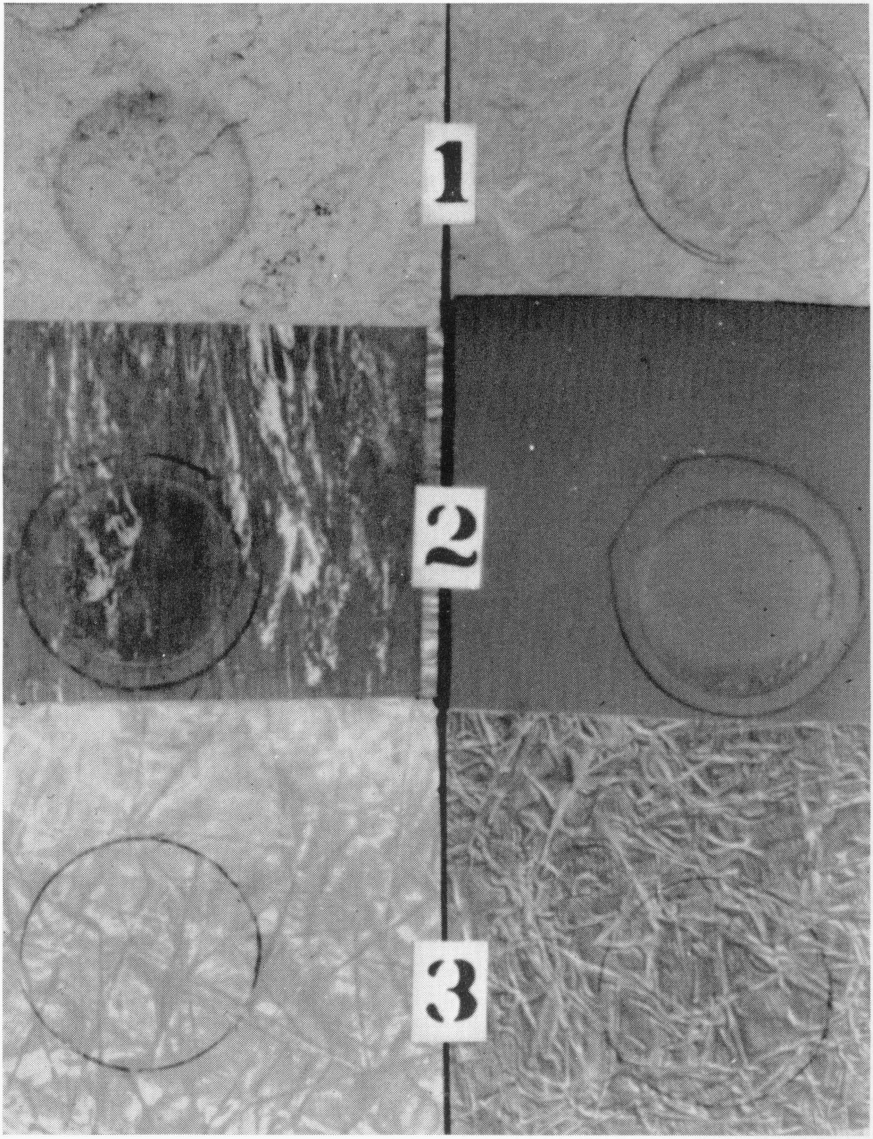

Fig. 1.—High temperatures, such as that of a skillet of hot fat, may cause damage beyond repair to some work counter materials.

1. **Linoleum—deep scorch through to the backing material.**
2. **Vinyl—melted and a deep, rough scar remained.**
3. **Some laminated plastic materials blistered.**

damage was sufficient that probably the spots would remain for the life of the material as a work counter finish. Boiling water left noticeable heat rings.

The laminated plastics varied in their responses to different temperatures. Four of the specimens, LP 2, 5, 6a, and 6b, showed no change at 420° F. except that the top melamine layer lost sheen giving the illusion of a change in color. At 382° F. these changes were not noted. With the other laminated specimens bubbles of varying sizes appeared under the surface and remained after the surface was cooled. In some the surface cracked through and around the bubble. In LP 4 the backing was heavily scorched. In the boiling water test the glaze of the finish was slightly affected on several of the laminated plastic specimens.

Dry heat tests at 420° F. and 382° F. left only a slight heat pattern on the steel specimen while the boiling water test, when water was applied, left noticeable water stains.

Tile specimens showed no changes at any temperature in either dry or wet tests. The wood specimen scorched at both 420° F. and 382° F.

Test III. Resistance to Cigarette Burns

Tests devised by other agencies required the use of a radiation calibration block, thermocouple potentiometer and other special devices for testing resistance of work surface finishes to cigarette burns. The cost of such equipment was prohibitive for this program so a simple, practical means was used which was considered typical to that which might happen in the home.

Test procedures:

Test materials were cut into squares of approximately 6 by 6 inches. Each square was clipped by a jig to a piece of plywood and placed in close proximity to an open window allowing a slight draft of air to pass over it. A long-size cigarette was cut into 2 pieces of equal length, lit, laid upon the test specimen approximately 3 inches apart and allowed to burn to completion. In case the cigarette "went out" before burning to completion the test was repeated. No tests were used to determine burning temperatures.

Following the tests the specimens were washed with a mild soap and water, dried, and then wiped with ethyl alcohol.

A panel of 6 judges scored the specimens. (See Table 5.)

Results of the test:

Stainless steel, tile and two of the laminated plastic specimens resisted the effects of burning cigarettes. Two other laminated plastics

TABLE 5.—The Resistance of Work Counter Surface Finishes to Burning Cigarettes as Scored by a Panel of Six Judges*

Material	Average score	Response of Material	
		Before washing and rinsing	After washing and rinsing
Linoleum			
L 1a	1.00	Deep scorch, blistered	Deep scorch, stain, rough
L 1b	1.20	Some scorch, blistered	Some scorch, stain, and blister
L 2a	1.20	Some scorch, blistered	Some scorch, stain, and blister
L 2b	1.00	Deep scorch but no blister.	Deep scorch and scorch stain
L 2c	1.00	Deep scorch, blistered	Deep scorch, stain, rough
Vinyl			
V 1	1.00	Melted and fused to ash	Melted and blistered
V 2	1.00	Melted and fused to ash	Melted and blistered
V 3	1.33	Burned, some blisters	Scorch stain, blistered
Laminated Plastic			
LP 1	2.33	Rather heavy surface stain	Slight stain
LP 2	2.33	Some surface stain, slightly blistered	Slight stain and blister
LP 3	1.66	Heavy stain and blistered	Slight stain and blister
LP 4	2.00	Stain only	Slight stain
LP 5	4.00	Slight surface stain only	Barely discolored
LP 6a	4.00	Slight surface stain only	Barely discolored
LP 6b†			
LP 7	2.33	Surface stain	Some stain
LP 8	1.00	Heavy surface stain, blister	Some stain and blister
Steel			
S 1	4.00	Surface stain	No stain remained
S 2	3.66	Surface stain	No stain remained
S 3	4.00	Surface stain	No stain remained
Tile			
T 1	4.00	Surface stain	No stain remained
T 2a	4.00	Surface stain	No stain remained
T 2b	4.00	Surface stain	No stain remained
Wood			
W 1	1.33	Scorch and burn	Scorch and burn

*4 points—no damage
3 points—very slight damage
2 points—moderate damage
1 point —considerable damage
0 points—very badly damaged

†Through error, 6b was missed in the scoring.

showed no damage other than a change of color; two, LP 3 and 8, were damaged badly enough to be considered non-resistant.[4] (See Table 5.)

Linoleum, vinyl, and wood specimens were all damaged to the extent that they could not be considered repairable. Should a burning cigarette have fallen and burned out on any of the vinyl materials studied the scars would have remained for the life of the material, the tests showed. (Figure 2.)

It may be said, however, that none of the materials flamed or gave any indication that a fire might be created by the burning cigarette when resting directly on these materials.

Test IV. Resistance to Impact

Surface finishes have been known to damage from the impact of fallen objects. For example, one homemaker surveyed reported that a glass knocked from an upper shelf chipped the laminated plastic surface on her counter. This and other known situations brought consideration to such questions as: "Is the material resilient enough to absorb shock without damage?" or "Will fallen objects break, chip, crack or dent the materials?"

Test procedures:

Test specimens of 4 by 4 inches were cut from each material and bonded to a ¾-inch hard wood plywood core. Each specimen was placed on a smooth flat surface. A hollow tube 3 feet long and 2 inches in diameter was held upright and centered against the specimen. Through the hollow tube a ½-pound steel ball, held in position by a magnet, was dropped. The tests were repeated with a 2-pound steel ball.

The specimens were scored by a panel of 6 judges according to the degree of recognizable damage. (See Table 6.)

Results of the test:

When the ½-pound steel ball was dropped none of the materials except tile showed sufficient change to be considered damaged.

When the 2-pound ball was dropped the damage was obvious. Linoleum and vinyl showed less indentation than did other materials (Table 6). Linoleum, because of its resiliency, had a tendency to recover and after a period of several weeks, the indentations did not

[4]The laminated plastic materials advertised as "cigarette proof" have a layer of aluminum foil under the decorative layer. None of the specimens in this test were of that quality since it is not recommended for counter areas where large hot utensils might cause finish to buckle.

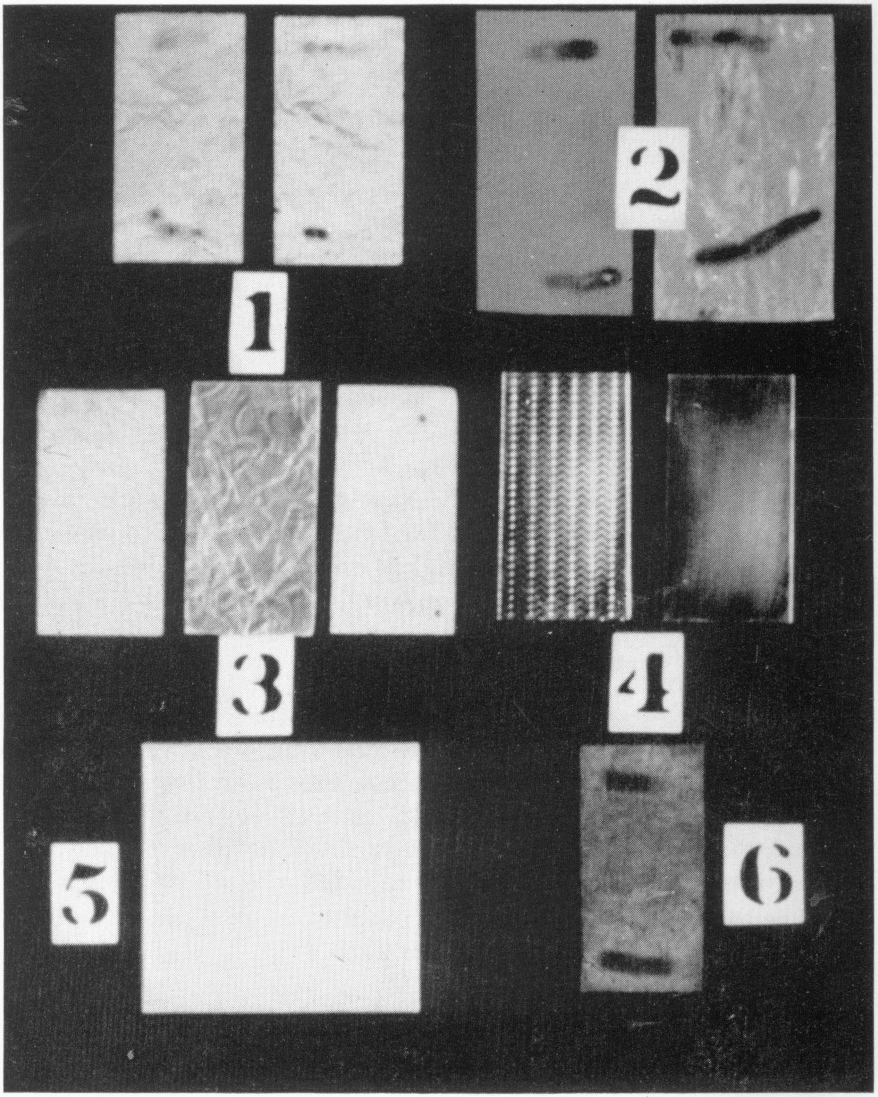

Fig. 2.—Burning cigarettes may affect work counter materials.

1. Linoleum samples show deep scorch but did not ignite.
2. Vinyl materials melted and ash fused but did not ignite.
3. Laminated plastics may show scorch or blister; sample to left was unaffected.
4. Steel—no effect.
5. Tile—no effect.
6. Compressed wood—scorched but did not ignite.

appear to be as deep. Vinyls recovered to a slighter degree. All of the laminated plastics dented and cracked at the point of impact, some to a lesser degree than others. (Figure 3.)

TABLE 6.—Resistance of Work Counter Surface Finishes to Impact as Scored by a Panel of Six Judges*

Material	Average Score
Linoleum	
L 1a	2.25
L 1b	1.75
L 2a	1.75
L 2b	2.00
L 2c	1.75
Vinyl	
V 1	2.50
V 2	1.75
V 3	1.50
Tile	
T 1	0.00
T 2a	0.00
T 2b	0.00
Wood	
W 1	2.25
Laminated Plastic	
LP 1	1.25
LP 2	1.25
LP 3	1.25
LP 4	1.25
LP 5	1.25
LP 6a	1.50
LP 6b	1.25
LP 7	1.25
LP 8	1.50
Steel	
S 1	1.25
S 2	1.50
S 3	1.75

*4 points—no recognizable damage
3 points—slight damage
2 points—moderate damage
1 point —badly damaged
0 points—completely damaged

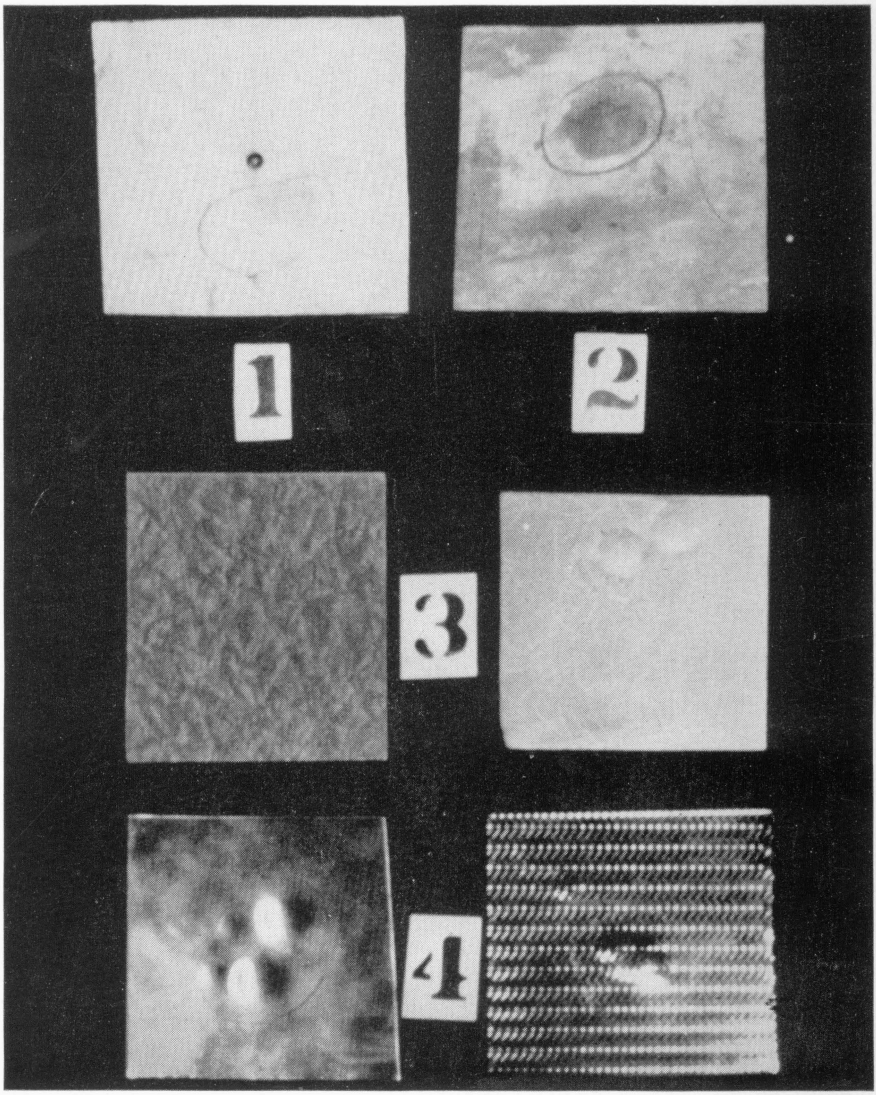

Fig. 3.—Work surface materials may be affected by impact. A two-pound steel ball dropped from a distance of three feet left dents in (1) linoleum, (2) vinyl, and (4) stainless steel. (3) Laminated plastics were not only dented but also melamine top layer was shattered around site of impact. (Tile shattered beyond photographic use.)

All stainless steel specimens were considerably dented and tiles were shattered by the 2-pound ball (Table 6). Although bonding held the tile together the top surface crumbled off and in a home situation replacement would probably have been considered necessary. Pressed wood also showed some indentation.

It is recognized that information of value would have been gained by repeating tests with weights between one-half and 2 pounds to determine at which weight the damage to a given material would be first evident; however, this series of tests was done late in the program and supplies of certain materials had become exhausted.

Test V. Resistance to Sunlight

Bright, sunny kitchens have gained in popularity. Formerly 2- by 3-foot windows were placed 10 or 12 inches above sinks; now we find 4- by 6-foot windows placed at 4 to 6 inches. With southern or western exposures for these or other kitchen windows it is anticipated that many hours of direct sunlight will hit the counters, or some part of them, during the course of the year. This question then arises: "Are the colors of the surface finishes fast to sunlight or will they lighten, darken, or become a contrast to other colors in the kitchen with which they are blended when new?"

Test procedures:

A. Specimens 2¼ by 4 inches were cut from materials for testing and placed in an Atlas Fade-o-meter, model FDA-R, in order to compare color fastness under more nearly controlled conditions.

B. The test specimens were mounted in a masking holder so that approximately half of the area was exposed to sunlight. The specimen holder was placed on a cylindrical framework perpendicular to the radiation of the light source and were exposed for 48 hours. A temperature of 100° F. was maintained with an exhaust fan ventilating the arc.

The panel of 6 judges scored the exposed samples according to any change in surface texture, color, crazing, or evidence of deterioration. (See Table 7.)

Results of the test:

The stainless steels and 4 of the laminated plastics showed no change in color or texture whereas the remainder of the laminated plastics showed only a slight change as did the vinyl materials (Table 7). Linoleum specimens showed moderate to considerable change in color. None

TABLE 7.—Resistance of Work Counter Surface Materials to Color and Texture Change when Exposed to Light in a Fade-o-meter for 48 Hours, as Scored by a Panel of 6 Judges*

Material	Average score	Original color	General response of materials
Linoleum (marblized)			
L 1a	1.7	Beige	Darkened and yellowed
L 1b	1.5	Yellow	Turned brownish color
L 2a	2.3	Beige	Lost color
L 2b	3.5	Dark green	Dark retained color, light colors faded
L 2c	2.3	Light beige	Lost color
Vinyl			
V 1	3.0	Gun metal (plain)	Slight change in color
V 2	3.7	Marblized	Slight yellowing
V 3	3.8	Marblized green	Very slight yellowing
Laminated Plastic			
LP 1	3.8	Bluish-gray (patterned)	Slight crazing of pattern layer
LP 2	3.7	Tan	Darkened
LP 3	3.7	Gray	Slight yellowing
LP 4	3.2	Green	Darkened
LP 5	3.2	Red	Darkened
LP 6a	4.0	Green	No change
LP 6b	4.0	Gray	No change
LP 7	4.0	Blue	No change
LP 8	4.0	Gray	No change
Steel			
S 1	4.0		No change
S 2	4.0		No change
S 3	4.0		No change
Tile†			
Wood			
W 1	3.2	Brown	Color lightened

*4 points—no recognizable damage
3 points—slight damage
2 points—moderate damage
1 point —badly damaged
0 points—completely damaged

†Tile specimens were too thick and too heavy to fit into frame of the Fade-o-ometer.

of the specimens showed deterioration with the exception of a very slight crazing of LP 1. It was thicker than other specimens and may have been subjected to undue pressure when placed into the masking device used for testing.

Manufacturers of linoleum, vinyl and laminated plastics sent samples of their products in a variety of colors available at the beginning of the study. These samples, being of suitable size, were used for some preliminary testing for color fastness in the Fade-o-meter for 48 hours; they were then examined and returned to the Fade-o-meter for a total of 96 and 120 hours. Of all the colors, reds and yellows in the various materials were the most susceptible to color changes. Blues and greens were the most stable.

Test VI. Resistance to Moisture

In the survey that preceded the laboratory testing 14 of the 102 homemakers surveyed complained of rotting and soggy surface materials around sinks and water pipes and the presence of mildew. While factors other than moisture may have been responsible for the condition, it was assumed that some materials might be more susceptible to moisture absorption than others. For an appraisal the following procedures were used by a technician at the Chemical Engineering Laboratory, The Ohio State University:

Test procedures:

A. Three test specimens, 1 by 3 inches, were cut from all test materials except stainless steel and glazed tile, both of which were considered impervious to moisture. The specimens were machined to remove any rough edges and rubbed with emery cloth.

B. Prior to the test, all specimens were conditioned in an oven at 50° C. (± 3° C.) for 24 hours and then weighed (conditioned or dry weight) on an analytical balance, and the thickness was measured at the center to the nearest 0.0001 inch with a machinist's micrometer.

C. The conditioned specimens were entirely immersed in a beaker of boiling distilled water. At the end of 2 hours, the specimens were removed from the water and wiped with a dry cloth after which they were immediately weighed and the thickness measured at the center. Results were calculated as follows:

$$\text{Increase in weight (percent)} = \frac{\text{Wet weight} - \text{Conditioned weight}}{\text{Conditioned weight}} \times 100$$

$$\text{Increase in thickness (percent)} = \frac{\text{Wet thickness} - \text{Conditioned thickness}}{\text{Conditioned thickness}} \times 100$$

Results of the test:

Of the 18 specimens tested there was a weight increase of from 1.15 to 27.01 percent (Table 8). According to the N.E.M.A. standard,[5] laminated materials having a nominal thickness of 1/16 inch should show a gain of not more than 6 percent in either weight or thickness. Only 1 laminated plastic specimen, LP 6, exceeded that amount in weight and it was so minor that it could have been within the experimental error of weighing. This same specimen, although well below the standard limitation of thickness change of 6 percent, did increase more in thickness than did the other specimens. Some variations appeared with vinyl specimens. Specimen V 2 increased only 2.08 percent in weight but 10.80 percent in thickness whereas V 3 increased 12.30 percent in weight but, in comparison, only 11.30 percent in thickness (Table 8).

Linoleum specimens varied from 7.77 to 11.01 percent increase in weight and from 3.26 to 7.09 percent increase in thickness.

Test VII. Resistance to Cutting

Cut marks, observed in numerous homes during the survey, indicated practices of cutting with knives directly on the surface materials. Although no standardized tests were found to evaluate the resistance of a material to such practices, it seemed pertinent to this study to make a practical test for appraisal by the panel of judges.

Test procedures:

Squares, 9 by 9 inches, cut from each of the test specimens except tile were clamped to a plywood core and placed upon a scale.

A good grade steel butcher knife, lightly sharpened between each test, was brought down and across the material 20 times in the same manner and with approximately 5 pounds of pressure as the investigator found she would use in cutting bread and sandwiches.

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[5]Standards and Recommended Practices of Fabricating and Applying Laminated Thermosetting Decorative Sheets, National Electrical Manufacturers Association, New York 17, N. Y. Pub. No. LP2—June 1951, page 13.

TABLE 8.—Average Percent Increase in Weight and Thickness of Work Counter Surface Materials Following Water Absorption Tests*

Material	Increase in Weight	Increase in Thickness
	Percent	Percent
Linoleum		
L 1a	7.94	4.70
L 1b	7.77	7.09
L 2a	7.97	6.74
L 2b	8.40	3.26
L 2c	11.01	6.78
Vinyl		
V 1	1.79	1.96
V 2	2.08	10.80
V 3	12.30	11.30
Laminated Plastic		
LP 1	4.71	0.43
LP 2	4.65	1.82
LP 3	3.32	2.17
LP 4	5.84	1.42
LP 5	4.01	2.48
LP 6	6.15	3.81
LP 7	4.42	1.75
LP 8	1.15	0.58
Tile		
T 1 (unglazed)	2.85	0.00
Wood		
W 1	27.01	16.29

*Steel specimens, not susceptible to water absorption, were eliminated from this test.

The panel of 6 judges scored the materials according to apparent depth and degree of cut and appraised damage to the specimens. (See Table 9.)

Results of the test:

None of the materials, except glazed tile, was found to be resistant to cutting with a sharp knife; all other materials showed moderate to considerable ill effects (Table 9).

The melamine finish on the laminated plastics showed definite cuts which would obviously be permanent. The linoleum and vinyl materials, however, indicated an ability to "heal." After standing for several days the cuts in these specimens, especially in linoleum, appeared to be less noticeable. The slightly ridged steel specimen showed very little marking but the plain surface specimens bore deep scratches.

TABLE 9.—Resistance of Work Counter Surface Materials to Damage by Cutting Action with a Sharp Knife as Scored by a Panel of Six Judges*

Material	Average Score
Linoleum	
L 1a	1.77
L 1b	1.82
L 2a	1.33
L 2b	1.17
L 2c	1.82
Vinyl	
V 1	1.00
V 2	1.17
V 3	1.70
Tile	
T 1	4.00
T 2	3.66
T 3	4.00
Wood	
W 1	1.00
Laminated Plastic	
LP 1	1.50
LP 2	2.00
LP 3	1.50
LP 4	2.50
LP 5	1.50
LP 6a	1.00
LP 6b	1.50
LP 7	1.33
LP 8	1.50
Steel	
S 1	1.50
S 2	2.17
S 3	3.66

*4 points—no damage
3 points—slight damage
2 points—moderate damage
1 point —considerable damage
0 points—badly damaged

Test VIII. Resistance to Wear

One of the factors of wear to which a work counter surface is frequently subjected is that of abrasion created by sliding of objects across the surface. Some objects may be smooth; others, such as cast iron or aluminum skillets or crockery and pottery items, may have rough bottom surfaces. In the course of time, the action is bound to cause wear.

Test procedures:

Test specimens, 4 inches square or circles 4 inches in diameter, were placed in a control room with a temperature of 70° F. and a relative humidity of 60 percent for 24 hours to assure uniform conditions at the time of testing.

All specimens were weighed on an analytical balance before and after abrasion of 1,000 and 5,000 revolutions of a CS17 test wheel, respectively, and the percentages of loss calculated. Record was made of the number of revolutions at which abrasion began to be noticeable (wheel tracks) and at such time as the pattern of the surface, if any, was destroyed. A Taber Abraser (model E-4010) was used for this test.

Results of the test:

After a 1,000 revolution cycle of the abraser test wheel there were noticeable tracks on all of the steel and vinyl specimens. Four of the 5 linoleum specimens showed wear. Only 1 laminated plastic, 6A, showed any ill effects. (Table 10).

Steel specimens were given not more than the 1,000 revolutions for two reasons: (1) a definite abrasion pattern appeared after only 100 to 200 revolutions and (2) there was concern for damage to the abrasion wheel.

In the 5,000 revolution test the abrasion wheel cut so deeply that the patterns of the linoleum were destroyed between 1,200 and 3,000 revolutions. Although track patterns were evident after 100 to 1,000 revolutions on vinyl, the pattern (marbelized effect) was not destroyed, nor was the material worn to the backing. Laminated plastics withstood the 5,000 revolution tests with minor effects. Wheel tracks became evident between 500 and 2,000 revolutions, but the pattern was destroyed on only one of the 9 specimens. (Figure 4).

Following the 1,000 revolutions the abrasion area of each specimen was marked off into 6 equal spaces. Five staining materials—grape juice, liquid detergent, liquid chlorine bleach, tea, and rust—were added; one space was left as a control. These tests were done under the same temperature and atmospheric conditions as had previous staining tests.

TABLE 10.—The Effect of Abrasion upon the Work Counter Surface Materials

Material	1000 Revolutions		5000 Revolutions		
	Weight loss	Noticeable track	Weight loss	Noticeable track	Pattern destroyed
	Percent	Number revolutions	Percent	Number revolutions	
Linoleum					
L 1a	0 010	100	0 860	100	3000
L 1b	0 006	100	0 330	100	1200
L 2a	0 006	100	4 950	100	2500
L 2b	0 010	500	0 140	500	3000
L 2c	0 130	500	1 510	500	2500
Vinyl					
V 1	0 160	100	0 500	100	——
V 2	0 038	1000	0 110	1000	——
V 3	0 038	500	0 213	500	——
Laminated Plastic					
LP 1	0 005	——	0 005	2000	——
LP 2	0 054	1000	0 110	1000	——
LP 3	0 036	1000	0 310	1000	——
LP 4	0 060	1000	0 270	1000	——
LP 5	0 030	1000	0 130	1000	——
LP 6a	0 030	500	0 190	500	——
LP 6b	0 040	1000	0 150	1000	——
LP 7	0 070	1000	0 120	1000	——
LP 8	0 030	1000	0 004	2000	——
Steel*					
S 1	0 019	100	——	——	——
S 2	0 004	100	——	——	——
S 3	0 040	200	——	——	——
Tile†					
Wood					
W 1	0 080	100	0 460	100	——

*Because steel showed heavy tracks before 1000 revolutions and because of concern for wear of abraser wheel, steel was not subjected to 5000 revolutions

†Test wheels were not suitable for testing of tile

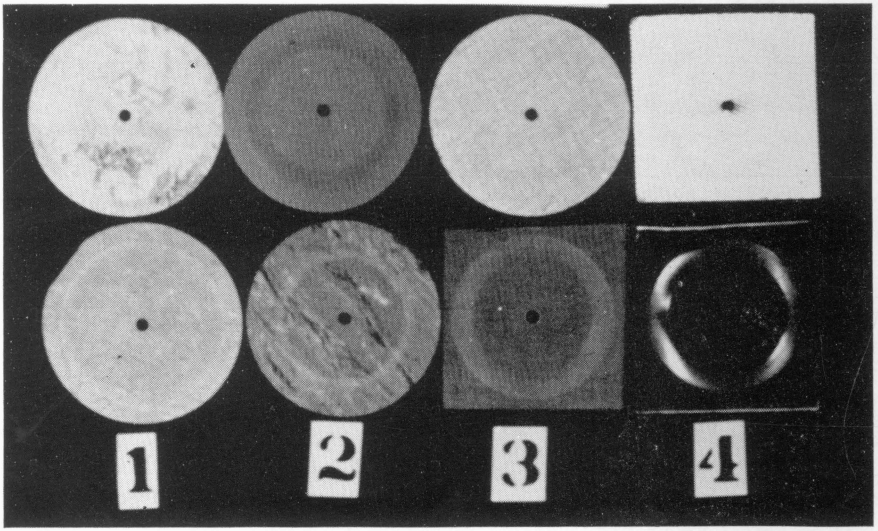


Fig. 4.—The dragging of heavy or rough items across a work counter may affect the surface materials by abrasion. An abrasion wheel used in this study magnified the results and showed resistance of the materials to wear.

1. **Linoleums**
2. **Vinyls**
3. **Laminated plastics**
4. **Stainless steel**

In this attempt to ascertain whether materials were more subject to staining after abrasion than before, the synthetic liquid detergent slightly roughened and dulled the abrased spots on several of the laminated plastics, left stains similar to water marks on steel, affected color on linoleum, but showed no effect on vinyl. Chlorine bleach left slightly roughened and bleached spots on 4 of the laminated plastics, deepened the color on 1 and showed no effect upon the other 4; spotted and removed color from linoleum and wood but did not affect other abrased materials. Sections treated with grape juice, tea, and rust showed little or no noticeable changes.

TABLE 11.—A Summary of the Resistance of Work Surface Materials to Various Treatments*

Material	Stain	Heat		Cigarette burns	Impact	Sunlight (Color change)	Cut marks	Abrasion*	Moisture absorption‡
		420° F.	350° F.						
Linoleum									
L 1a	A	D	B	D	B	C	B	D	B
L 1b	B	D	A	D	C	C	B	D	B
L 2a	A	D	A	C	C	B	B	D	B
L 2b	A	C	A	D	B	A	B	C	B
L 2c	A	—	—	—	C	B	B	C	B
Vinyl									
V 1	A	D	C	D	B	A	B	D	A
V 2	A	D	C	D	C	A	B	B	A
V 3	A	C	C	C	C	A	B	C	B
Laminated Plastic									
LP 1	A	B	A	B	C	A	C	—	A
LP 2	A	A	A	B	C	A	B	A	A
LP 3	A	B	A	C	C	A	C	A	A
LP 4	A	C	A	B	C	A	B	A	A
LP 5	A	A	A	AA	C	A	C	A	A
LP 6a	A	A	A	AA	C	AA	C	B	B
LP 6b	A	A	A	—	C	AA	C	A	A
LP 7	A	B	A	C	C	AA	C	A	A
LP 8	A	B	A	D	C	AA	C	A	A
Steel									
S 1	A	A	AA	AA	C	AA	C	D	AA
S 2	A	A	AA	A	C	AA	B	D	AA
S 3	A	A	AA	A	C	AA	A	D	AA
Tile									
T 1	A	AA	AA	AA	D	—	AA	—	A
T 2a	A	AA	AA	AA	D	—	A	—	A
T 2b	A	AA	AA	AA	D	—	AA	—	A
Wood									
W 1	B	B	A	C	B	A	D	D	C

Average Score:

*AA 4 points—no effect
A 3-4 points—slight effect
B 2-3 points—moderate damage
C 1-2 points—considerable damage
D 0-1 points—serious damage

†A 1500-2000 revolutions of abrasion wheel and over
B 1000-1500
C 500-1000
D 100- 500

‡AA No absorption
A Less than 6 percent
B 6 to 12 percent (inc.)
C 13 percent and over

ESTIMATES OF COMPARATIVE COSTS OF MATERIALS FOR WORK COUNTER SURFACES

When the women interviewed earlier in this study were asked what factors they considered most important in choosing a work surface, durability and ease in care were listed by 72 percent while only 23 percent mentioned cost. It is probable, however, that in making a final selection the size of the family pocketbook would have more influence than this limited survey might indicate.

One of the aims of this study was to ascertain comparative costs of the materials. Four kitchen plans representative of the one-wall, corridor, L- and U-shaped kitchens (Figures 5a to 5d) having continuous or broken work counter areas were submitted to local suppliers and contractors who had agreed earlier to make the estimates. Only a few responded in detail; thus it is difficult to give what might be considered good estimates. Others gave a blanket statement of cost per square foot according to material used. These figures fell far below those of the more carefully estimated costs. Others recorded "guesses" without breaking down costs between materials and labor, indicating that they would need to do "on the job" estimates. Realizing that these estimates would bring no immediate returns to the individual or company, several dealers responded with, "We are too busy to bother." Reports from several people planning to build or remodel who called our laboratory seeking such information, indicate that they, too, had had considerable trouble getting estimates when they were "shopping around."

The companies dealing exclusively with floor covering and related materials were better prepared than were those companies carrying such materials as a side line to give accurate and definite information, estimates, and assistance. It was found also that the specialized dealers could provide wide selections of immediately available materials at more reasonable costs.

In fairness to the fine cooperation of and conversations with several suppliers, their estimates and suggestions will be reported on the following pages. (The reader may wish to use one of the plans for comparison with those of his own needs when building or remodeling.) It should be recognized that the prices quoted are estimates and not always directly related to the number of square feet of counter top.

Factors affecting estimates were:

(1) Number of broken areas or right angle installations which required more time to install and more material than continuous unbroken areas.

(2) Whether material was fabricated at factory, shop, or in the home.

(3) The grade of material and type of fabrication used. In case of linoleum the thickness and brand varied in cost. Laminated plastics ranged greatly in price. The low pressure, thinly veneered variety which comes in a roll varied widely in quality and cost with that of the heavy sheet factory fabricated variety. Stainless steel installations, for example, may be either flat steel bonded on a wood core or a molded made-to-order installation with a single or double compartment sink as a part of the unit. As would be expected, the latter would be by far the more costly.

SUMMARY

The purpose of this investigation was to determine the suitability of available materials for work counter surfaces from the standpoint of durability, satisfaction, and care with minimum effort and to ascertain relative costs of materials and installation.

To ascertain actual problems encountered with work surface materials in homes, 102 homemakers were interviewed.

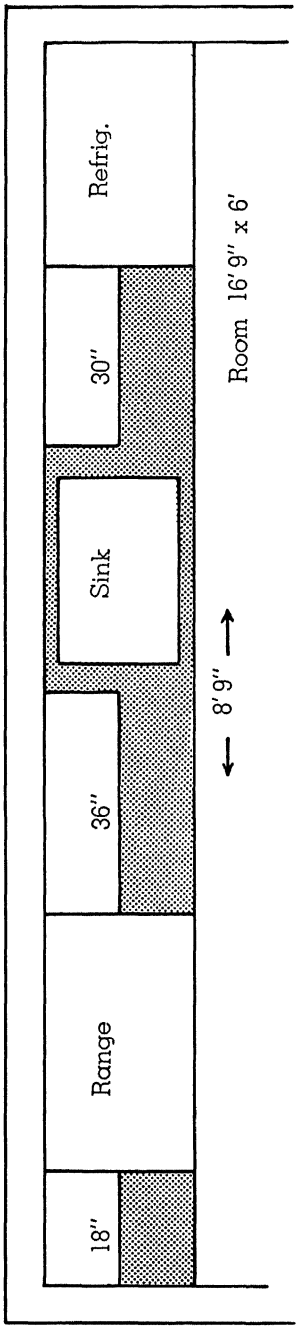
In 41 homes having linoleum, 31 women considered it satisfactory. Grievances of others regarding linoleum included deterioration around sinks, stains, pits and scratches. In the 29 homes where laminated plastics were in use all users were satisfied with the material as were the 19 users of stainless steel and the 7 of vinyl.

Laboratory tests done under controlled conditions were made on 24 different materials: 5 linoleums, 3 vinyls, 9 laminated plastics, 3 stainless steels, 3 tiles, and 1 processed wood.

Resistance to stain. In the stain resistance tests linoleums and vinyls were found to be similarly affected and retained some degree of stain from mustard, grape juice, vinegar, food coloring, bluing, and ink. Vinyls, however, were more resistant to all-purpose soaps, synthetic detergents and other cleansing supplies than were linoleums.

Laminated plastics showed no, or in a few cases only the slightest, effect from any of the 36 materials used in the stain tests.

Stainless steels showed some surface change to the majority of staining materials, particularly to water, cleansing supplies, and acids. One steel material finely corrugated showed less effect than the flat surfaced steels.



Estimates of Relative Costs of Some Materials for Work Counter Surfaces (20.5 sq. ft.)

	Materials alone	Installed
Linoleum	$14.00	$36.90
Vinyl	18.50	44.40
Laminated plastic	42.50 to 96.10	90.00 to 153.75
Stainless steel	——	222.00 to 275.00
Ceramic tile	——	118.00 to 138.00
Wood		
Hard	102.50	143.50
Pressed	10.25	20.50

Fig. 5.—(a) The One-wall Type Kitchen.

Corners and broken areas add to installation costs. Cutting the opening for installation of sink generally costs about $10 extra.

Estimates of Relative Costs of Some Materials for Work Counter Surfaces (27.0 sq. ft.)

	Materials alone	Installed
Linoleum	$17.00	$47.25
Vinyl	22.75	57.20
Laminated plastics	85.00 to 165.00	121.50 to 202.50
Stainless steel	——— ———	289.00 to 365.00
Ceramic tile	——— ———	162.00 to 200.00
Wood		
Hard	135.00	189.00
Pressed	13.50	31.00

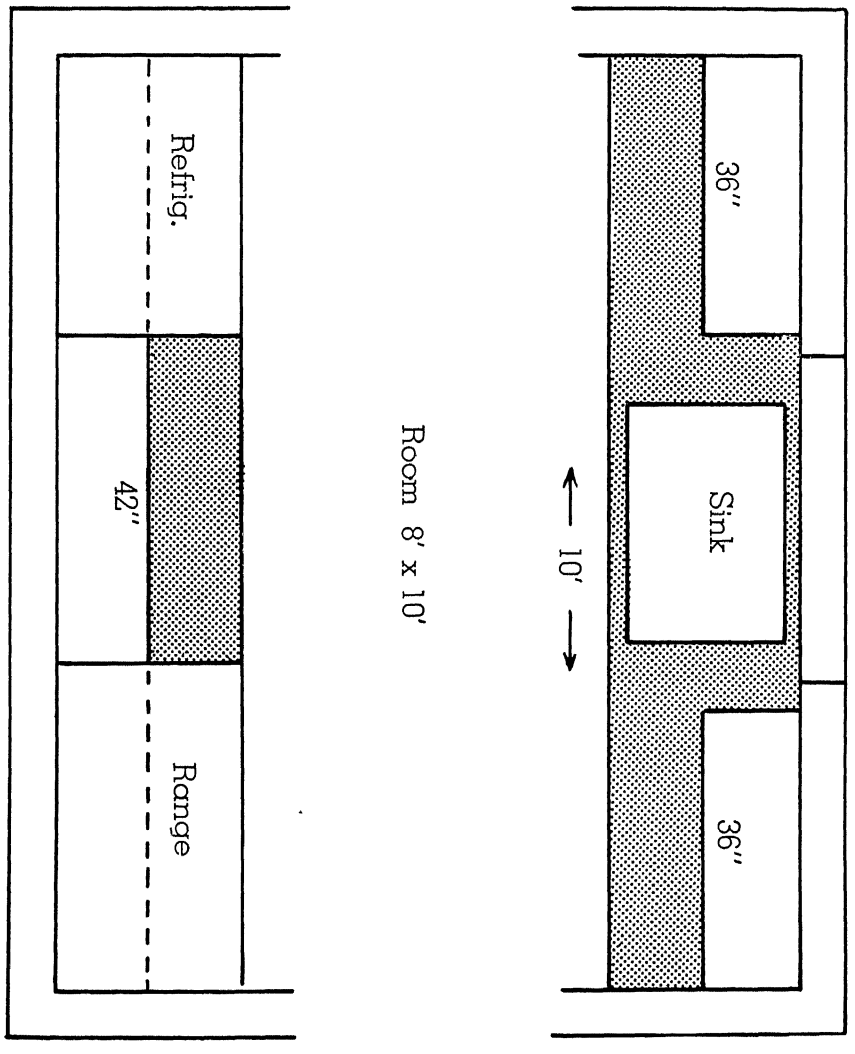


Fig. 5.—(b) The Corridor Type Kitchen.

Estimates of Relative Costs of Some Materials for Work Counter Surfaces (39.0 sq. ft.)

	Materials alone	Installed
Linoleum	$21.00	$66.50
Vinyl	28.45	76.60
Laminated plastics	89.00 to 200.00	225.00 to 325.00
Stainless steel	——— ———	282.00 to 618.00
Ceramic tile	——— ———	234.00 to 264.00
Wood		
Hard	195.00	273.00
Pressed	19.00	35.00

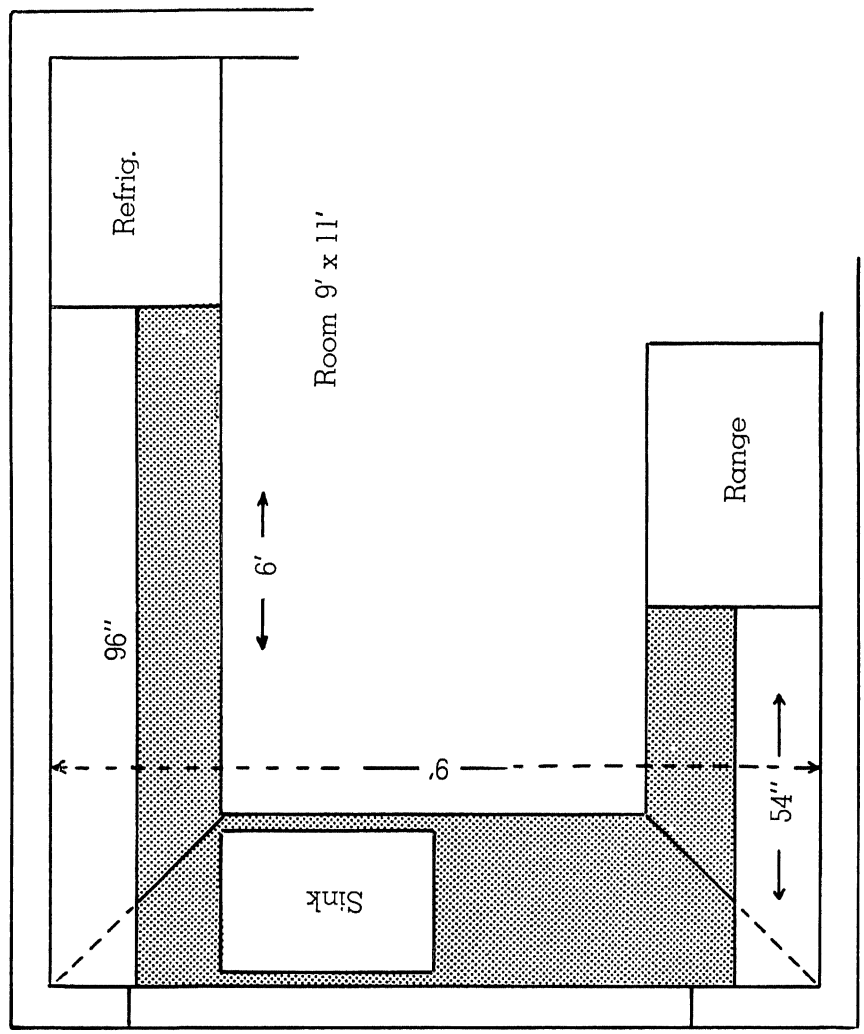
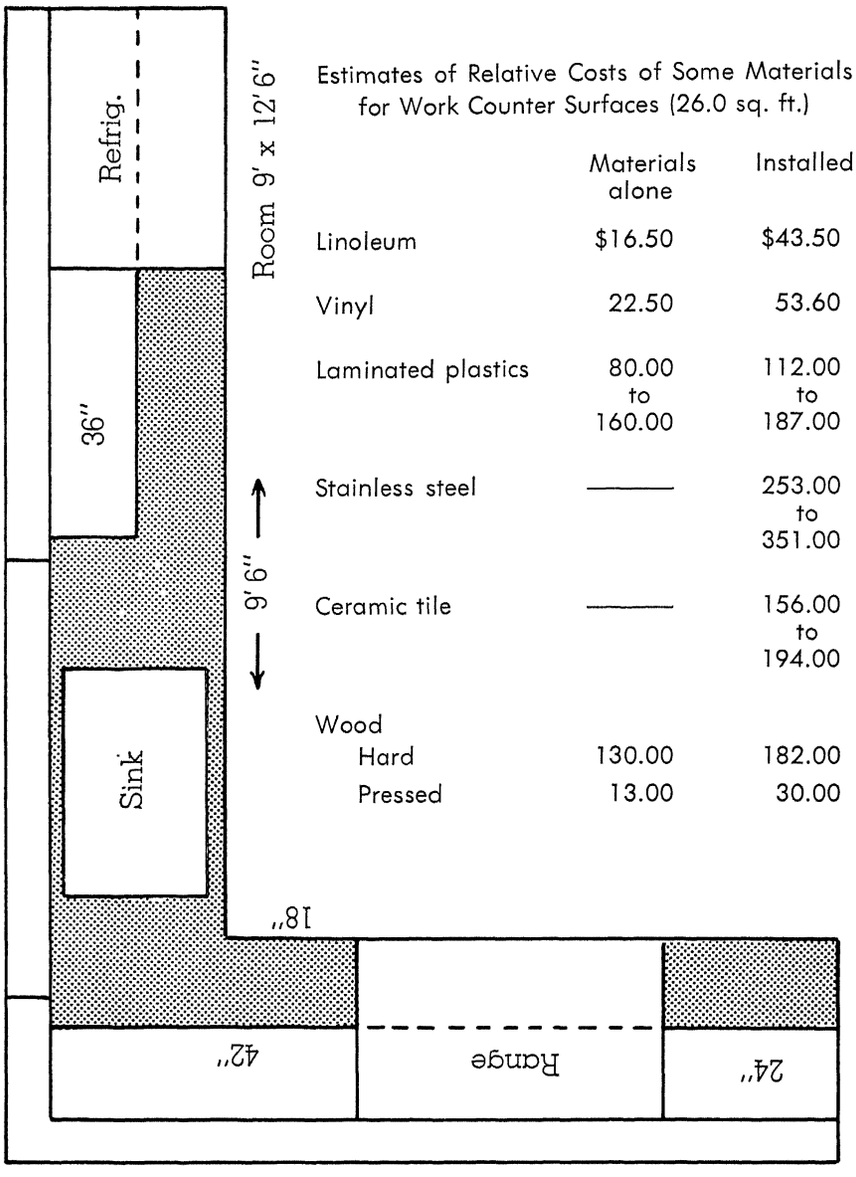


Fig. 5.—(c) The U-type Kitchen.



Estimates of Relative Costs of Some Materials for Work Counter Surfaces (26.0 sq. ft.)

	Materials alone	Installed
Linoleum	$16.50	$43.50
Vinyl	22.50	53.60
Laminated plastics	80.00 to 160.00	112.00 to 187.00
Stainless steel	———	253.00 to 351.00
Ceramic tile	———	156.00 to 194.00
Wood		
Hard	130.00	182.00
Pressed	13.00	30.00

Fig. 5.—(d) The L-type Kitchen.

Tile, particularly the glazed variety, had splendid resistance to staining, but showed some surface change when cleansing agents were applied. Unglazed tile was affected by fats.

Untreated processed wood was readily affected by most stains.

Resistance to heat. Vinyls were found to be highly susceptible to heat; they not only scorched through the backing materials at the lowest test temperature of 350° F., but also the utensil stuck leaving large blisters and roughened surfaces.

Linoleums were only slightly affected at 350° F. but scorched through to the backing at 420° F.

None of the laminated plastics showed any effects at 350° F. but at 420° F. half of the number blistered and the remainder showed permanent color changes.

Stainless steel showed only slight discoloration at 420° F.

Wood scorched at 420° F. but showed no ill effects at 350° F.

Tile was the only material not showing some surface effects to some degree from heat.

Resistance to cigarette burns. Tile and stainless steel showed no effects after cigarettes were allowed to burn out on the surfaces. Some of the laminated plastics were slightly discolored and blistered. Linoleums showed scorch, stain and some blistering. Vinyls melted and fused with the ash and butt. Wood charred on the surface. None of the materials ignited.

Resistance to impact. When a one-half pound steel ball was dropped from a 3-foot height, little or no damage to any of the materials was evident. When a 2-pound steel ball was dropped all materials were affected: linoleum dented, but due to its resiliency appeared to recover; vinyls responded similarly; all laminated plastics were indented and cracked at the point of impact; steels were heavily dented; tiles were shattered.

Resistance to sunlight. In the 48-hour Fade-o-Meter tests all linoleum samples changed color to some extent; vinyls were only slightly affected. Four of the laminated plastics were unaffected, 4 darkened slightly, and 1 crazed on the surface. Wood color lightened slightly. Stainless steel showed no change. The thickness of tiles prevented their being included in this test.

Resistance to moisture absorption. In this test linoleums increased in weight from 7.77 to 11.01 percent, and in thickness from 3.26 to 6.78 percent. Vinyls varied from 1.79 to 12.30 percent in weight increase and from 1.15 to 6.15 percent in thickness. Laminated plastics increased

from 1.15 to 6.15 percent in weight and 0.43 to 3.81 percent in thickness. Of the latter only one exceeded the standard limitation of 6 percent set by the National Electrical Manufacturers Association. Tile absorbed only 2.85 percent of its weight. Untreated processed wood absorbed 27.01 percent and expanded 16.29 percent in thickness. Since steel is non-absorbent, samples were not subjected to this test.

Resistance to cutting. Most materials showed cut marks made by a sharp steel butcher knife used for bread cutting. Tiles were the most resistant. Steels appeared scratched. Cut marks in linoleum appeared to "heal" after a period of time and became less apparent. Cuts in vinyl and laminated plastics appeared permanent and would probably be retained for the life of the material.

Resistance to abrasion. Laminated plastics, with the exception of one brand, showed a high degree of resistance to abrasion and noticeable tracks did not appear until the abrasion wheel had made 1,000 revolutions. Patterns from the abrasion wheel were quickly noted on stainless steels. Linoleum patterns were destroyed within 1,300 to 3,000 revolutions. Vinyls were more resistant than were linoleums. Tile could not be used in this test.

Relative costs of work counter surface materials. In general, the estimates of costs per square foot of materials installed as given by dealers were: linoleum, $1.75; vinyl, $2.60; laminated plastics, $4.50 to $7.50; stainless steel, $9.75 to $13.50; ceramic tile, $6; hard wood, $7.50; pressed wood, $0.50.

Estimates for the costs of the materials alone were from 50 to 75 percent of the installed cost.

CONCLUSIONS

The results of this study indicate that no one material has all of the qualities that one might desire for a work counter surface. It would seem that good grade laminated plastics might come as closely to the desired characteristics as any material studied. These materials had splendid resistance to stain, heat, moisture absorption, impact, abrasion and color retention. While they are not resilient as are linoleums and vinyls, they are not "noisy". Likewise, they can be obtained in a wide range of colors and patterns to match any desired color scheme. Good grade, rigid, high pressure thermoset plastics should not be confused with the low pressure flexible type (comes in rolls) if durability is desired.

The installation of the rigid thermoset plastics is the job of a skilled workman and, as yet, the costs are beyond that permitted by the average family budget.

Vinyl, except for its susceptibility to heat, can be considered a good product at moderate cost. Its resistance to deterioration by moisture and detergents should result in greater durability than that of linoleum.

Resiliency of linoleum and its "healing" ability to cuts and impacts are desirable qualities. It is reasonably priced but by nature of its composition can hardly be expected to last as long as some of the more durable and expensive materials. Both linoleums and vinyls are flexible and lend themselves more readily to home installations by the family handyman than do most other materials.

Durability is a strong argument for tile and stainless steel. Both are hard, non-resilient materials. Their resistance to moisture absorption, corrosion and heat makes them particularly suitable in damp, humid climates. Ceramic tile was more resistant than steel to staining.

The durability and appearance of wood as a counter surface finish will be dependent upon the seal, finish, and care given; unless well treated it will stain easily, absorb moisture readily, and roughen.

APPENDIX I

Considerations for the Consumer

When asking for estimates of the cost for materials or for materials and labor for installation of work surface materials the prospective customer should:

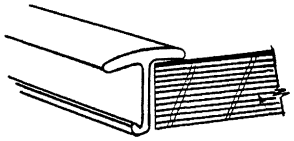
(1) **Know the exact dimension of the work area.** Estimates are frequently quoted on either the square foot or lineal foot basis. Since the width of materials vary, some of them cut to better advantage than others. For example, a 30-inch laminated plastic material will cut a 24-inch work counter plus a 4- to 6-inch splash back. If it is desirable that the "splash back" reach up to wall cabinets or window or that a "splash end" on the wall at right angles to the end of the cabinets be added, these requirements must be considered in the estimate. Some materials are of wider widths allowing for a high splash to be cut from the running length.

(2) **Indicate to the supplier or contractor the needs for the core or wood base to which the material is to be bonded.** When the surface material is merely being replaced the core or wood base already in place may do for some materials. If, however, it is rough, warped, or affected by moisture, replacement will be necessary. It is important with the new high pressure laminated plastics that they be fabricated on a hard wood plywood; otherwise, the pattern of the wood may work through the surface pattern of the material.

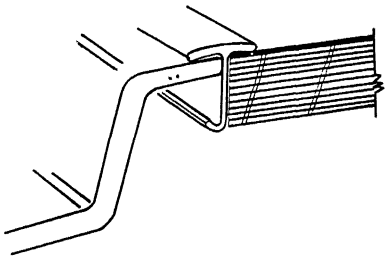
(3) **Plan with the contractor for the type of trim to be used.** A recent "style" has been to use the surface material rather than metals as a trim around front and side edges of the counters and also to use a cove steel trim at the back of the counter where it joins the splash and to use a J-shape molding to seal around the flat rim sink. This edge trim of the some material requires real skill in cutting and applying. Various stainless steel, aluminum and plastic trims are available at various costs.

(4) **Know the type of sink to be used.** The type of sink used will affecte the cost of work counter installation. Prices quoted for flat rim sink installations into the counter ranged from $7 to $10. The use of cabinet or roll rim sinks will require a snug fit against the counter but will not require a cut-out area.

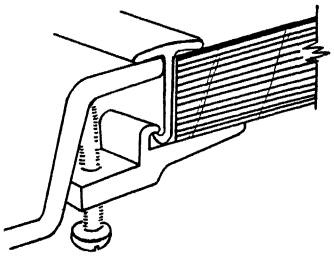
Past experience with linoleum rotting around flat rim sinks had discouraged several of the women interviewed; they said that they wanted neither linoleum nor a flat rim sink when replacing their present arrangement. Recently, new methods and devices for sealing have been developed to prevent water from getting under the edges of the surface.



A J-shape molding is placed on the work counter around the sink opening.



The flat-rim sink is brought up under the molding to counter level.



Clamps hook into the lower rim of the J-shape molding and screws are tightened to hold sink firmly in place. Caulking may be put under the rim of the molding to seal surface base from water absorption.

Fig. A1.—A satisfactory method for installing a flat-rim sink on the same level with the work counter.

This study did not involve sinks but the opportunity to mention one factor in installation cannot be passed up. Contractors frequently drop the flat rim sink below the work counter. If this type of sink is used, *do insist* upon the rim being brought up level with the work counter. (See Figure — for a satisfactory method of installation.) Suitable work heights for the homemaker can make the difference between a task being tiring or not tiring. Each homemaker spends a considerable amount of time at the sink. Most sink compartments are 6 or more inches deep. When installed with the rim at counter level this depth places the bottom of the compartment at 30 inches or less above the floor—a height found to be too low to be comfortable for most women. If, however, the rim is placed below the work counter, the height will be lowered another 1 to 1½ inches, which is much too low and uncomfortable for even the shortest women. A comfortable standing position free from stoop and strain reduces the amount of energy used in dishwashing or any task.

APPENDIX II

Materials Available for Work Surface Finishes

Such questions asked as, "What are vinyls made of?", "Are vinyls a substitute for linoleum?", "What other names are there for formica?", "Wouldn't plastic tile be satisfactory for a work counter as it's so much cheaper than other kinds?", imply confusion in the minds of people as to the composition of the various finishes.

Few people would be expected to be acquainted with all of the available materials unless they are actively engaged in the building trades. When faced with choosing materials for new or remodeled houses or when merely replacing a work counter surface the variety of available materials, advertising, and sales pressure make decisions difficult for the average person.

It seemed pertinent in this report to describe at least briefly the classifications and materials used for study with hopes that their manufacturing processes, uses, and characteristics might be better understood.

To obtain this information, we asked various manufacturers and trade association representatives to provide descriptive information concerning their different products. The following explanation of the materials is a compilation of the data provided for our use.

LINOLEUM

Linoleum has been widely used for floor coverings for nearly 100 years and during the past three decades it has been the most widely used material for work surface counters in modernized and newly built kitchens.

Linoleum is made from linseed oil, resins, wood gums, chalk and color pigments. The term *linoleum* is derived from the Latin words *linum* (flax) and *oleum* (oil).

Linseed oil (flaxseed oil) when exposed to air thickens to a rubber-like consistency. A *cement* is made of the oxidized oil, resins from pine trees, and gums. These are cooked until they thicken and blend. Cork and wood ground to fine dusts, called *flours,* and color pigments are worked into the *cement* and the result is called a *linoleum mixture.*

This mixture is fed to a *scratcher* machine having two rollers, one hot and the other cold. The hot roll softens the mixture which in turn clings to the cold roll. Spikes on a rapidly revolving roller scratch the mixture into small particles or grains from the cold roll. This granular mass goes through the calendering machine where burlap or felt paper passes between the machine's two large, heated rolls. Under pressure of the rolls the grains fuse, and the fused material is squeezed and smoothed on the burlap or felt paper which serves as a backing material.

The linoleum is soft at this stage and must be *cured* or hardened in stoves for days or weeks depending upon the thickness and quality of the linoleum. The linoleum just described is known as *inlaid linoleum* in which the colors extend from the surface to the backing material.

Inlaid linoleums vary in thickness from about one-sixteenth to one-fourth of an inch. The thinner grade is generally used for work counter surfaces. *Battleship linoleum* is the thickest and is so-called because it was first made for naval ship use.

Printed linoleums are thin, plain-colored felt paper backed on which an oil paint design has been printed. The two types of linoleums should not be confused when being considered for work counter materials for which only the inlaid variety is suitable. Printed linoleums are the least expensive of the linoleum coverings.

Inlaid linoleums are available in a wide variety of colors, plain and marbleized, or in molded patterns. In case of the latter, the linoleum is prepared without backing in various sized blocks and strips. The patterns are fitted on a backing material and then squeezed through heated rolls to fuse the pieces into one. *Molded inlaid linoleum* is made by sifting various colored grain mixtures through stencils onto a backing

material. A different stencil is needed for each color used. *Embossed linoleum* has irregular surfaces in the design which are formed by the dies of a molding press and give such appearances as tiles, bricks, or flagstones.

Manufacturers give trade names to the various linoleums and linoleum materials which they make. Linoleum suitable for work counter surfaces will come in rolls in varying widths and colors.

VINYLS

Vinyl is a new post World War II word to be added to the materials vocabulary. It resulted from the development of synthetic rubber. Recently, such terms as plastic linoleum or synthetic linoleum have been used to classify the vinyls in the *covering materials* group. Vinyl, a product of petroleum, is being used to a considerable extent in place of linseed oil used in the manufacturing of linoleum.

The manufacturing process of vinyl materials for floor and work counter surfaces is similar to that of linoleum. Materials used include the synthetic basic resins, color pigments, plasticizers—which are oils and resins that aid in processing by helping to disperse or mix all ingredients thoroughly—and fillers such as asbestos or fibrous talc which add stiffness and body.

In manufacturing, the pigments, plasticizers, and fillers are processed into a mixed and congealed mass before being carried to the mill. The milling operation is the point where the hot plastic mass is further processed to further complete mixture of all ingredients in a way similar to the mixing of concrete. *Calendering* is the step whereby the hot plastic mass is rolled to desired thickness or gauge. The final step is an *annealing* process which takes the "shrink" from the material. It might be compared to Sanforizing of fabrics. The material in ply form passes through a battery of lights which fuse the plies, or layers, together. Then by a series of pressure rolls they are merged into one thickness.

The annealing process has not been perfected by all manufacturers and in some cases difficulty with shrinkage has been encountered.

Vinyl materials are being made by linoleum manufacturers as well as by manufacturers of rubber products.

While vinyl is a synthetic product it should not be considered a substitute for linoleum. Manufacturers maintain that vinyl materials have some characteristics which are more advantageous than those of the linseed products. It is not affected by moisture and alkaline materials which tend to dry out and deteriorate linoleum; neither will it support

combustion or mildew or bacterial growth. They also maintain that freedom from backing material makes the vinyl product freer from dimensional change—shrinkage or buckling.

Considerable differences will be found in the vinyls on the market. The process of manufacturing described here will give a product comparable in appearance to a good inlaid linoleum where the color will extend through the complete thickness. This quality of product suitable for use for work counter surfaces should not be confused with the more thinly veneered on felt-backing type. Prices vary from $2.00 to $8.00 per square yard. Only three vinyls were included in this study, but since this study of work counter finishes was started numerous other brands of these products have come on the market.

LAMINATED PLASTICS

Since World War II thermoset laminated plastic materials for work surfaces are comparative newcomers for home uses. These materials are known under such trade names as Formica, Micarta, Texolite, Panelyte, Ornalite, Parkwood, Satisply, Versibond and others.

In the manufacturing of laminated products of a good quality used for work counters, a special Kraft paper or cloth is used as a filler. (Figure 6). This paper or cloth is impregnated in a continuous length by passing it through a bath of resin; drying is done in a heated steam tunnel; and it is then cut into required lengths. Several sheets of this paper (7 or more) are stacked and on top is placed a design sheet impregnated with melamine resin which may be a plain color, a printed design, a paper-thin genuine wood veneer, or even cotton fabric. On the very top is placed the all-important protective overlay sheet which is heavily saturated with 100 percent melamine. This top layer is the toughest and hardest of all plastics.

These stacked sheets are then covered with a press sheet of stainless steel with a finish that will give a dull or a glossy appearance to the finished product, and placed in a hydraulic press. Manufacturers vary as to the pressures used in processing; so products may be known as high or low pressure thermoset laminated plastics. In the high pressure variety the layers are put under approximately 1,200 pounds pressure per square inch at 280° F. for 60 minutes and are gradually cooled before the pressure is released. This process bonds together these individually impregnated layers into a single sheet that cannot be soaked or split apart.

Cigarette-proof grades of these materials have an additional sheet of metal foil under the decorative sheet to guarantee against blistering from

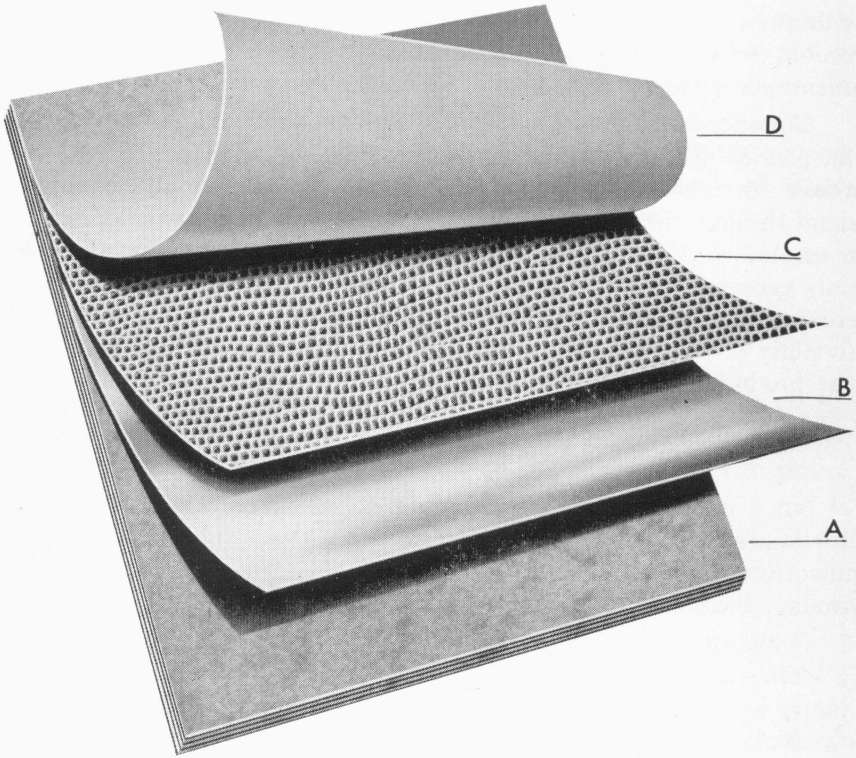


Fig. A2.—Laminated Plastic products for work counter surfaces.

A. Layers of a special Kraft paper or cloth which have been impregnated with a resin.

B. Sheetof aluminum foil makes material "cigarette proof". This layer is not used for work counter materials as foil might expand too much under hot utensils.

C. Decorative sheet which may be of printed paper, cloth, or a thin layer of wood which has been impregnated with a resin.

D. The all-important melamine overlay sheet which is saturated with 100% melamine. This top layer is the hardest and toughest of all plastics.

cigars and cigarettes. This grade *should not* be used on kitchen counters since the application of larger areas of heat (such as a skillet) could cause the material to buckle.

These laminated materials are generally veneered to a plywood core which provides rigidity and support when placed on cabinet bases or tables. This fabricating process is important to the durability and wearing qualities of the material. Since this process generally requires special adhesives and pressure some manufacturers do the fabrication or rely upon skilled workmen to do it at retail level. Since the laminates are very hard, brittle materials, special tools are needed for cutting and trimming, thus making home installation by the family's handyman questionable. In a home installation it is important that the sheet laminated material (not previously fabricated) be sealed to a hard wood plywood; otherwise, the wood pattern of a soft wood might eventually work through the pattern of the finish.

Since this study was begun one manufacturer has come on the market with a 3/16-inch thick thermoset laminated material that is of a one piece seamless construction with a molded cove back splash and a rolled front counter edge. Because of its thickness and weight it can be installed upon wood batten strips for support, and no sealing to a plywood core is necessary.

STEEL—ENAMELED AND STAINLESS

Steel is used in various forms for work areas: as a stainless variety for counter surfaces and/or sinks, or as the basic metal for porcelain enamel finishes on sinks or for tops of ranges, water heaters, or dishwashers, and other appliances which might serve as a part of a work counter.

Sheet steel, used as base metal, is made of iron ore, coke, limestone and air. The first product of this combination of materials is called pig iron which is later melted with steel and iron scrap in an open air furnace together with more limestone, iron ore and fluorspar and is refined to make low carbon steel. To the liquid steel as it comes from the furnace such materials as ferro-manganese are added, and the steel is poured into rectangular ingots and then rolled into slabs.

The slabs are reheated and passed through sets of rolls which reduces the thickness and lengthens the material. Finally, the rolled sheet is made into a coil while hot. When cool, the coil is put through an acid bath called the pickling process to remove scale and oxide layer; then, after washing, it goes through one or more rolling mills where it is ground and polished.

It is customary to heat-treat steel before or after its final cold rolling to give correct internal structure and toughness to stand the pressing, forming, or welding necessary in manufacuring the final product.

Porcelain enameled steel: Since many kitchen appliances are finished in porcelain enamel and may fit into work counter areas, a knowledge of the material's properties is essential.

The varieties of porcelain are unlimited, but a "recipe" is chosen for resistance to conditions to which it may be subjected in use—acids, alkalis, abrasion, heat or a combination of these factors.

A porcelain enamel coating is actually a high-quality glass with coloring and opacifying agents added to give white or other colors. This glass is ground to a powder and mixed with a liquid. The steel base materials are dipped into or sprayed with the glass mixture and placed into a furnace at approximately 1500° F. The glass fuses or melts into the pores of the base metal.

In recent years titanium compounds have been used for enamels where stain resistance is important; the quantity of this product is still limited, but its further use will undoubtedly be favorably accepted in porcelain enamels used for sinks, appliance tops and work counters.

Baked enamel: The use of the term "enamel" in connection with both porcelain and baked synthetic paints has been confusing to prospective buyers and users of appliances. The differences are particularly significant when the top of an appliance is used as a section of a work counter.

As said above, *porcelain enamel* is a powdered glass fused on steel at high temperature. *Baked enamel* is a plastic resin base paint sprayed on steel and baked at lower temperatures. The steel with better grade finishes of this type has been treated with a process known as Bonderizing before the paint is applied. Bonderizing is a chemical treatment in which the surface of steel is converted to a protective coating by chemical reaction. This coating, insoluble in water, retards rust in that it is highly resistant to the effects of moisture. It also provides a foothold for paint which retards flaking and peeling.

Baked enamel has been extensively used as the exterior finish for refrigerators, freezer cabinets, clothes dryers and the like. This finish is cheaper than porcelain enameling, thus reducing the cost of the appliance. Baked enamel finishes will not chip as does porcelain enamel but are sensitive to abrasion, scratching, and staining. These facts should be kept in mind if a washer, dryer, counter height water heater or refrigerator with such a finish is installed in a continuous work surface. In such cases a protective rubber pad or some such material can be used for a covering.

Stainless steel is made of carefully selected steel scrap melted down and refined and to which nickel (17% to 19%) and chromium (8% to 10%) are added in proper amounts. When these products are in molten state manganese and silicon are added and the molten mass is poured into ingots. The rolling, pickling, and finishing processes are similar to those of sheet steel described above, but are done with greater care. The finished stainless steel is not normally so ductile as ordinary steel and requires greater care in working or pressing into shape.

Stainless steel is considered the glamour metal of the steel family. Its beauty, cleanliness, durability, resistant to staining, and non-absorption qualities have made it suitable for work counter tops but its costs have made it prohibitive for the majority of homes.

To avoid confusion in the minds of inquirers it may be said that Monel Metal is a trade name for one of the high chromium content stainless steels.

For work counters, stainless steel is generally fabricated for special orders and to required dimensions. Some families have used flat sheet steel, bonding it to a core and trimming with a special trim, which is more economical than when fabricated to order.

Manufacturers have given various finishes to stainless steel—high polish, satin finish, or slightly corrugated patterns.

CLAY OR CERAMIC TILE

Ceramic tile, one of history's oldest building materials has long been popular for kitchen work surfaces and drain boards, particularly in certain sections of the nation.

The word "tile" has been used loosely in recent years to describe any material made in a conventional clay tile shape. True clay tile has a dense body, is one-fourth to three-eighths of an inch in thickness and cannot be bent by hand as can the plastic or metal "tiles."

Ceramic tile is made from clay and other ceramic materials and fired in kilns at very high temperatures (approximately 2000° F.) to produce a strong, durable material. Tile sizes may vary from very small "dots" to nine-inch squares and are made in a great variety of shapes and designs.

For kitchen work counter surfaces either glazed or unglazed types may be used. Glazed tiles for such installations should have a vitreous body and be so specified to a tile contractor. The size most often used is 4½ by 4½ inches. The glass-like finish of this type of tile is easy to clean and to keep clean.

Vitreous clay tiles used for kitchen work surfaces are usually small in size, two-inch squares as an example, but larger sizes are occasionally used when they fit into the scale of the kitchen. Small unglazed tiles are mounted on sheets of paper to make installation quicker.

Glazed tiles are made in about 200 shades of basic colors while the unglazed are made in about 100 shades. Tile contractors usually carry a limited line of colors but if given time may secure a wider range from the factory.

A clay tile installation for kitchen work surfaces should be done by an experienced clay or ceramic tile worker. Tile can be set over wood, concrete, steel plate and other materials. Over a wood surface, the tile contractor first applies building paper as a dampness protection, then secures shrinkage mesh or metal lath over the surface as a key for the mortar bed into which the tile is set. A tight, narrow joint between tiles should be specified for kitchen work surfaces.

On some new work and on much remodeling, clay tile contractors often use adhesives, but judgment as to use of mortar or adhesive should be left to the contractor.

Clay tile has advantages in the kitchen. If properly installed it provides a waterproof surface so that moisture conditions will not loosen it. It provides a durable finish little affected by conditions other than heavy impact.

WOOD AND PROCESSED WOOD

Natural wood for work counters has been in use for generations. With the development of new finishes its use, except as a base or core for the material, has not been as popular in the past two or three decades. Recently, however, the use of pretreated hard woods, cut in contour form, is gaining interest. In the survey of homemakers (page ??) over two-thirds of them said that they would like to have more than one type of material for a work counter surface. Over 40 percent indicated hard wood as their choice of one of the two materials.

No source of information could be found concerning the production of these pre-cut wood counters but the manufacturers of certain kitchen cabinets have made them an optional choice among other materials. Experience with several of these counters in foods and equipment laboratories at the School of Home Economics, The Ohio State University, indicates that additional penetrating seals or other finishes are necessary to make the wood stain and water resistant.

Processed or pressed wood has gained in use for various purposes in new and remodeled homes. Because of its versatility and possibilities of application of various surface finishes, processed wood stands to gain further popularity.

The manufacturing of such a product includes the drying and six months' seasoning of barked logs cut from mature trees. The logs, cut in short pieces, are chipped into thumb size pieces and screened. The wood chips are coated with a natural adhesive coating called lignin and poured into "guns" where high temperature steam is built up to great pressure and then suddenly released. By this process the wood chips are exploded into cellulose fibers which are refined and formed into a wet lap blanket. This blanket is trimmed into panel lengths and pressed into hard boards in a steam-heated hydraulic press. To temper, the boards are immersed in a hot oil bath and later humidified to restore the natural moisture content of the wood. Patterns simulating tile, leather, and other finishing treatments are used or the board may be left in a natural state for treatment in the home.

Manufacturers maintain that the processed woods have advantages over natural woods. These advantages include uniform strength in all surface dimensions; no splitting, splintering or cracking; resistance to moisture; resistance to denting, abrasion and scratching; and avoidance of waste from defects found in natural wood.

MATERIALS FOR WORK COUNTER SURFACES AND TABLE TOPS

Material	DESIRABLE CHARACTERISTICS	Less Desirable Characteristics
Linoleum	Very resilient. Deadens sound in kitchen. Does not break. Cuts, scratches and dents—appear to 'heal." Durable if well installed and cared for. Flexibility allows for continuous cove installation to include desired depth of splash. Waxed surface helps resist stains. Wide variety of colors which are available in designs or plain. Economical in price. Nonconductor of electricity.	Needs continuous waxing and good care to assure lasting qualities. Contrary to popular belief it is not "very easily" installed. Precautions are necessary to make installations waterproof so that wood core on which it is bonded as well as the linoleum will not absorb moisture. Moisture may create mildew in hot, humid weather. Detergents and other alkaline materials dry out oils causing deterioration and affecting color. Will show heat rings and scorch. Colors may be affected by direct sunlight.

Vinyl	Resilient. Deadens sound in kitchen. Flexibility allows for continuous cove installation. Is not deteriorated by alkalis or moisture as is linoleum. Easily cared for. Good resistance to stains. Available in wide variety of colors—attractive and decorative. Colors little affected by direct sunlight. Adaptable for home installation. Nonconductor of electricity. Reasonable in price.	Affected by heat. Hot skillet or appliance may stick, blister, roughen, or discolor the vinyl. Cuts, scratches and indentations tend to be more permanent than in linoleum. While resistant to most stains will be affected by dyes, some medical alkaline supplies, bluing. Affected by abrasion.
Laminated plastics, high pressure sheet	Very durable. Nonporous, glasslike surface. Remarkable resistance to stains, alkalis, acids. Easily cleaned and cared for. Available in wide choice of colors; designs on bright or dull finish. Edges of counter may be bound with same material eliminating metal trim if desired. Nonconductor of electricity.	Initial cost high. Most satisfactory when fabricated at factory (bonded to wood core.) Installation except by skilled worker questionable. May warp unless well installed. Will scratch, show knife marks, and abrasion from rough bottom utensils. Although it has good resistance to shock and impact it will dent and/or crack if impact is sufficient.
Laminated plastics, low pressure, roll variety	Smooth, nonporous, glasslike surface finish. Very satisfactory resistance to staining. Available in good variety of colors and patterns. Nonconductor of electricity. Easily installed by the family handyman. Reasonable in price.	Thin veneer subject to blistering and cracks with heat and damage from impact. Shows cuts and scratches.
Stainless steel	"Life-time" durability. Hard surface, nonabsorbent, not affected by heat. Will not crack, chip, or break. Resistance to some ordinary stains. Seamless construction of molded type eliminates seams and trim. Corrugated designed steel and other flat sheets may be installed by the family handyman and are more reasonable in price than the molded variety. Corrugated variety does not show abrasion and stains as readily as smooth steel.	Very high initial cost beyond the reach of the average pocketbook. Not resilient, quiet, or colorful. Reflects light. Shows scratches and abrasion. Will dent with hard impact. Although considered stainless, will show some stain and discoloration from acids, alkalis, and water. Will conduct electricity.

Tile, ceramic	Durable, smooth, hard surface. Easily cleaned when well installed with minimum amount of joining material exposed. Resistant to practicall all stains unless abrasion has affected surface glaze. Resistant to mild abrasion. Attractive selection of many colors, sizes, and shapes. Unaffected by heat.	Hard, rigid, and noisy. Glaze produces some light reflectance. May crack or break with impact. Unglazed variety susceptible to some stains. Initial cost high—installation not a job for the amateur.
Wood, hard	If well seasoned has a hard, smooth surface. Heat resistant and makes a splendid cutting surface. Laminated most suitable. Very durable. Moderate price. Easily treated or refinished.	Need occasional renewal of treatment or finish to prevent staining. If not finished is difficult to keep clean. Solid wood may warp. Unless well seasoned the tops made of narrow pieces may spread apart.
Pressed	Economical in price. Hard, smooth finish. Makes good cutting surface. Easily cleaned when treated.	Needs to be well sealed or frequntly treated to prevent staining and moisture absorption.

Gentlemen:

This year, at the Ohio Agricultural Experiment Station, we are undertaking a research project dealing with the determination of suitable work counter materials and finishes used in homes from the standpoint of installation, maintenance, durability, and cost. This study is a subproject of the Housing Needs and Preference Study of families in the North Central Region.

For our information we should like to know if you manufacture a product for use on home work counter surfaces. If so, would you please suggest the departmental member with whom we could further correspond regarding the product?

Sincerely yours,

(Mrs.) Elaine Knowles Weaver
Research Associate

THE OHIO AGRICULTURAL EXPERIMENT STATION

Wooster, Ohio

WORK COUNTER SURFACE SURVEY

Date ———————————

Enumerator ———————————

Name ———————————

Address ———————————

Occupation of Husband ——————wife——————

Location: City——Town——Village——Rural Non-Farm——Farm——

Tenure: Own——————Rent——————

House: Age—————— How long have you occupied it?——————

Size of family: Adults—————— Children——————

Kitchen: Size (Approx.) ———————————

Has it ever been remodeled?————Why————When————

Number of lineal ft. of straight work surface: 1)—2)—3)—4)—

Depth: 1)—2)—3)—4)—

Right Angle: 1)—2)—3)—4)—

Name of material used for work surface——————

Name of manufacturer of work surface material——————

What material is used for the back splash?——————

Height of back splash——————

Method of installing back splash? Cove—Right angle—

Type of trim or filler used——————

Color of work surface material chosen——————

Cost: Material—————— Labor—————— Both————

Problems of installation——————

———————————

Installed by whom?——————

Sink: Flat rim——Rolledge——Back splash——Cabinet——

Trim around sink——————————————————

Double sump——————————— Single sump———————

Drain boards: Single left——Single right——Double———

Location of faucets: Through the sink———————

Through the work surface———————

If you were to replace your sink what would you choose?——

Flat rim——————————— Roll edge———————

Condition of Work Surface Material:

Excellent——— Good——— Poor——— Very poor———

Characteristics: Stains———————

	Temporary	Permanent
Water		
Lemon juice		
Vinegar		
Bleach		
Soap		
Others		
Tea		
Coffee		
Alcohol		
Detergents		
Heat		
Others		

Rotting ——————————— Cause———————

Pitting ——————————— Cause———————

Warping ——————————— Cause———————

Burns or scorch ——————————— Cause———————

Scratching ——————————— Cause———————

Type of trim: Counter surface trim: Flat———Raised rim———

Sink trim: Flat———Raised rim———

Aluminum——— Stainless Steel——— Plastic———

Does it rub off?———Do you like it?———Why?———

If you have a drain board, is it a satisfactory work surface?———

Reasons:———

Do you consider your present work surface material satisfactory?———

If replacing it today would you use the same material?———

If no, what would be your choice?———

Would you like more than one kind of work surface material in your kitchen? ———

If so, what kinds———and———why?———

Do you have a cutting board?———Is it handy?———

Do you always use it for cutting or chopping?———

Would you like to use part of your work surface as a cutting board?

———

Some work surface materials are applied under pressure at the factory: does this affect your choice of material?———

Would you rather have the work surface applied directly in your home? ———

How do you care for your present work surface material?———

———How often?———

Do you use synthetic detergents for dishwashing?———

Have these synthetic detergents affected your work surfaces?———

How? ———

What determined your choice of work surface material?———

———

Type of cabinets?————Custom built————Type of finish————

Do you have a dishwasher?——If so, is it a part of the counter surface—

Do you have a garbage disposal unit?————————————————

Do you have a porcelain top table?————————————————

Is it used as a work counter surface?————————————————

Is the family laundry done in the kitchen?————Hand laundry?————

Does the homemaker do the work herself?————Who helps?————

CONTENTS

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